AN

INQUIRY

HOW FAR THE

VITAL and ANIMAL ACTIONS

Of the MORE PERFECT ANIMALS

Can be ACCOUNTED for

Independent of the BRAIN.

In FIVE ESSAYS.

Being the Subſtance of the *Chandos* Lectures for the Year 1739, and ſome ſubſequent Years.

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M,DCC,LII.

In the following Sheets,

Page 34. *line* 19. *for* nobiliorem *read* mobiliorem.
99. *l.* 24. *f.* was *r.* as.
109. *l.* 14. *f.* quæ *r.* quo.
120. *l.* 12. *f.* mimoſa *r.* nimoſa.
134. *l.* 7. *f.* breaſts *r.* breaſt.
144. *l.* 9. *f.* breathed out *r.* breathed with.
218. *l.* 12. *f.* more ordinary *r.* ordinary.
223. *l.* ult. *f.* Ariæo *r.* Arcæo, Angenio, Augenio.
260. *l.* 5. *f.* roughly vitiated *r.* throughly vitiated.

T O

Robert Simson, M. D. Professor of Mathematicks in the University of *Glasgow*.

Dear Brother,

I Here present you with five Essays on the vital and animal actions of the more perfect animals; for though, of late, we seem to have made a considerable progress in the theory of medicine, yet the causes assigned for these principal parts of the animal oeconomy, are not at all depended on.

The schools had indeed adopted certain maxims, which would have persuaded us that they had come to rest satisfied in their accounts of them; but some of the wiser part of the profession still shew a distrust in these accounts; and daily suggest some new considerations to make them perfect: And as I reckoned nothing of greater importance to medicine than a just theory, so I could find nothing whereby I could better answer the worthy design of the Founder of the

Chandos *lectures here, than to do ſomething to eſtabliſh theſe principal parts of it upon a ſure foundation. And indeed, if I miſtake it not, the foundations of theory and practice in our art are to be laid after the ſame manner, both of them by an exact obſervation of the occurrences in the body, and of what contributes to produce them. The theory conſiſts chiefly in obſerving ſuch as take place in health, and the irregular cauſes which diſturb them; the mere practice, in conſidering the irregular courſes, and what management contributes moſt to reſtore them to the more perfect ſtate, without regard to the cauſes. And who can imagine, that if we are not able to trace the more conſtant and regular courſes, that we ſhould be able to trace the irregular and leſs frequent? A very little thought muſt ſatisfy us, that the perſon who is not fit for the one, can never be fit for the other; and therefore genuine theory can never be cried down by any but the advocates for ignorance. I acknowledge we have had many bad theories which have done great miſchief, but not more than we have had bad accounts both of diſeaſes and medicines by profeſſed empiricks. And againſt this we have no better antidote than a juſt theory: the*

the more the ſprings of actions are traced in the body, and the more diſtinctly we view how every part is employed, we muſt be the more pointed and diſtinct in our obſervations of their diſorders. But nothing is to be depended on which we have not ſeen in one ſhape or another; our gueſſes are never to be admitted as part of our obſervations; though often we are obliged to do the beſt we can this way, in dangerous caſes, where we cannot get the evidence we wiſh for; and to evite it as much as poſſible, we repeat our obſervations. The great work is to bring to view, in the beſt light, what we would ſee, and then to tranſcribe it with accuracy; which requires no ſmall attention and art, no leſs than what we find in the ingenious face-painter, who, before he begins to draw, is well ſkilled in perſpective, in the doctrine of light and ſhade; and then, after he has drawn the outlines of his work, fills up every particular part with what correſponds in the archetype, according as his art directs: If he ventures to put any thing in of his own, he ſpoils the whole piece, and lies, while he publiſhes it as a tranſcript from nature. Here is required the piercing judicious eye to take a right view; an

eye trained up to direct the hand in transcribing; to give every part its due place, magnitude and shade, so as to make it appear uniform and just to the spectator.

If Physicians had entertained a just sense of this, their works would not have swelled to such an enormous bulk; and the few they published, like Raphael'*s paintings, would have always gained the applause of succeeding ages: whereas the small attention they have given, in examining and representing facts, has multiplied our theoretical and practical pieces greatly, without increasing our knowledge of what passes in the body: And thus it is that most of our medical writings are better fitted by way of ornament to our closets, than for the advantage of study; for amongst them the judicious inquirer tires himself greatly, and meets with little,* quod tollere vellet, *that is of value.*

The primitive Historians would naturally fall a describing things as they found them; the meeting with something curious being the first motive that we can imagine should have enticed people of genius and fancy to describe: And thus

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the first Poets and Physicians are reckoned to abound more with natural descriptions than the later, who seem to have taken the humour more to amuse and surprise, than to instruct their readers. It must indeed be owned, that in antient authors we sometimes find a mixture of romance joined with their better descriptions; and, if we were to admit all the pieces under Hippocrates's *name to be really his, we could hardly defend our great Founder from having used too much liberty in his accounts of things: But as we find many things, amongst his works, done after the best taste, we would be very unjust to him to put to his account what is otherwise; especially after the evidence we have how unjust posterity had been to him, in crouding in their naughty pieces with his elaborate works, without any distinction of names. We have no less than five spurious pieces amongst seven, upon epidemics; and the two acknowledged to be his, have cases added to them, most of them quite foreign to the constitution described; which shews the bad taste of those who had the collecting of his works: Nevertheless we have undoubted examples of the genius of that great man, both in investigating and describing what*

belonged

belonged to our art: how exact is he, in the two books of epidemics which we allow to be his, in describing the diseases and their various courses, according to the seasons that accompanied them? which Sydenham *has imitated to so much purpose, making this reflexion upon the method, that when it is followed out throughly, the observator has very little trouble in inventing remedies, which is reckoned the most difficult part of our work; for the history itself, if compleat, gives the best indications of cure. And the whole remedies* Hippocrates *used, appear to have been suggested by such indications. But in chronical cases, where the humours were less concerned, and the changes did not shew themselves so much, nor did proceed with such constant and equal steps, he was obliged to regard Anatomy more, to satisfy himself about the parts affected; their position, connexion, uses, and every other circumstance, as far as his industry and penetration could discover; and from this he was directed in his management and indications of cure. So far is it from being true, that this great pattern, in cultivating medicine, slighted the theoretical part of it. And indeed I look upon his example in this to be of*

so

ſo much importance to form the taſte, that I cannot give a better introduction to my Eſſays, than by giving ſome inſtances of the ſimplicity of his theory, and how it was wrought into his more practical pieces.

And this I reckon muſt be agreeable to you, dear Brother, by whoſe repeated advice and arguments I firſt engaged in the ſtudy of Hippocrates *with any warmth; I hope thereby to give you a proof, that I have had ſome ſenſe of the ſpirit of the author: And, if I have imitated his example in the caution and ſimplicity with which I have managed the argument in the following Eſſays, I ſhall not doubt of their being acceptable to ſuch of our profeſſion as are at pains to inform their judgment before they paſs ſentence. Nothing gives me more pleaſure, than the obvious and ſimple account which* Hippocrates *gives of the periodical evacuation which the ſex have ſo certainly upon their approach to their compleat ſtature. In a few words he tells us, in his book* de genitura, *that the* uterus, *by which this diſcharge is made, is impervious in the younger; but, increaſing with the other parts of the body,* *it*

it comes at length to have its vessels so much increased in bulk, as to transmit blood to its cavity. What more evident cause could be assigned for a phænomenon *happening, so invariably, with the growth of the body, so necessary for the reception of a child? For I cannot shew any regard to that hypothesis, That, upon completing the growth, there commences a redundancy of the blood, according to* Sanctorius, *of a pound or two; which no other statical examinator could ever confirm; and which is contradicted by every fact. Nothing is necessary for the* phænomenon, *and all the symptoms accompanying it, but a patent way; and the more patent it is, the discharge is greater, and with less disturbance: And thus, in the introduction to his first book on the diseases of the sex, he acquaints us, that these who have born children, by which the* uterus *is greatly stretched, have the evacuation with less disturbance. And in the* 15*th section, there he tells, that the blood evacuated in that case, in a person in health, is as pure as that shed in sacrificing; so that it comes unchanged from the mass. These are simple and plain accounts, and quite agreeable to the* phænomena. *And as by this*

account

account he appears to have been sensible, that the vessels of the uterus *opened into its cavity; so nothing could be more natural for him than to entertain the notion, that it was into these very passages the* placenta *was ingraft; especially if ever he had had the opportunity to see the pregnant* uterus *laid open, as I had lately in a woman, who died suddenly in the seventh month of her pregnancy; where, in separating the* placenta, *I drew out its processes, to the length at least of half an inch, in great numbers, rising all over the* placenta, *some of them as thick as a goose quill; nay, over the whole* chorion, *fibrous threads, as small as hairs, arose and penetrated into the uterine pores; but in pulling out these of the* placenta, *they immediately shrunk in, and appeared on it something like the granulated surface of the mulberry fruit. How much would such a view have confirmed his notion? But suppose he never saw it in the human* uterus, *yet what is seen in cows, which could not well escape one of his diligence, must have made this supposition probable to him; and consequently, that any thing which rendered this ingraftment less firm, would contribute much to produce an abortion. And when he*

 found

found that such as were subject to the fluor albus, *were most subject to abortion: What could he infer from this, but that this very flux of humours prevents the firmer ingraftment? as he declares in* aph. 45. lib. v. *and that bleeding would put the woman in hazard of abortion, as he declares* aph. 31. *since its native effect is to make parts subside when more than ordinary tumid, as is the* uterus *when pregnant; though 'tis probable the too frequent bad consequences of it, when tried upon the weak, had brought him to be so positive in ranking it among his maxims. From the same view of things he had certainly tried fumigation, so well fitted to open the pores in obstructions; whose success he declares* aph. 28. *And an attention to the correspondence between the breasts and* uterus, *had made him conclude, that the* placenta *had yielded when the breasts suddenly subsided, as we find he did*, aph. 37. *and, in consequence of this observation, ordered cupping to the breasts, to divert the uterine hæmorrhagy*, aph. 50. *though bleeding would not in the weak, who are most subject to these hæmorrhagies: Nothing causing a more sudden relaxation of the vessels than bleeding, as is observed*

by

by Duretus, *in his gloſſary upon* Hollerius de morbis internis, *where he treats of this ſubject*; Soleo ſæpe dicere et crebris uſurpare ſermonibus (*ſays this great Student of* Hippocrates) quod dum menſtrua quieſcunt, ſi vena ſecetur cientur; atque ideo vereor de ſanguinis detractione in gravidis mulieribus, non quod fœtus ſuo fraudentur genio, ſed quia ſanguis fertur ad uterum, unde citatis menſibus contingit abortus. *How different are theſe ways of judging in* Hippocrates *and* Duretus, *from that of our modern Plethoriſts, who having perſuaded themſelves, that neither exerciſe, abſtinence, or evacuations can prevent the* plethora, *make the ſuppoſition, that every woman keeping regular muſt be always plethoric; and that in pregnancy there can be no better remedy than bleeding. And thus, in ſome countries, the Ladies of diſtinction are regularly bled, to prevent abortion*; tanta prejudicata opinio potuit, ut etiam ſine ratione valeret autoritas!

I am far from imagining, that when one pregnant takes a diſeaſe which requires bleeding, that it is to be neglected: nor can any perſon imagine, that either Hippocrates *or* Duretus

could be ſuch ill judges as to neglect it in theſe caſes: But to make people uſe it with a due caution, it was juſt in the founders of our art to ſhew the native tendency of ſuch an operation.

The whole I have cited from Hippocrates *are plain and ſimple obſervations, agreeable to what is paſſing in the body, and to the mechaniſm of the parts, as we ſee them formed and connected, and in fact employed: And a ſmall pains and attention to that great man's writings, would furniſh us with more examples of this kind, than we are at firſt view aware of. We find, by his experiments, in his book* de corde, *that he laid himſelf out greatly in the anatomical way, to know the courſe of things; and through his whole works we meet with inſtances of it, eſpecially in the aphoriſms, which to me ſeems the beſt digeſted of all his works, and wrote in imitation of the* data *of the antient Geometers: They appear plainly to be a collection of the eſſential ſteps neceſſary to lead and guide us in the ſolution of problems relating to the diagnoſtics, prognoſtics, and indications of cure of moſt diſeaſes. They are ingeniouſly*

niously adapted to the Physician's use, to make him know the import of every thing passing with his patient, and to reduce into order what is irregular: How far what I have cited from them confirms this, I leave every one to judge; to me they give the greatest evidence, that Hippocrates's *attention to the circumstances of particular bowels, assisted him more in forming his practice, than what a more extensive knowledge in Anatomy has done the moderns, who seem to deal too much in general observations. The mass of blood, the circulation, and some few of the fluids seem to me to have ingrossed their attention. The circulation certainly has great effects, as have the spirits or nervous juice, and many other of the humours; but these must be all ascertained after the* Hippocratic *method, if we would reap advantage from them. Our assertions concerning them must be made plain and obvious, agreeable to what every one may discover who examines into the* phænomena *and structure of the parts concerned with them, and must lead us directly to comprehend the irregularities attending their actions.*

This

This has been my ſtudy in the following Eſſays, in explaining the animal and vital actions. The moſt obvious phænomena *attending them have been altogether neglected in the common explications of them; and others advanced greatly out of the reach of our ſenſes, and whoſe force is not at all explicable; nor is it eaſy to find how they ſhould be ſerviceable in the practice of Medicine.*

Nothing is more obvious than the changes I aſſert in the muſcles when acting; nothing more intelligible, nothing more conſiſtent with the powers of elaſtic bodies: This is not only evident in the more ſimple caſes, where the muſcles are employed, but in reſpiration and the circulation; in which actions, though all allow that the muſcles have a great ſhare, yet none of their accounts help us to underſtand the cauſe of their conſtant and involuntary acting in them. To explain this, we find nothing further to be conſidered, than what we ſaid in general on the muſcles, except the veſſels through which the circulation is carried on, and the action of the perſpiration in the breaſt; which is not an invention of mine, but has been more or leſs aſſerted

serted ever since the force of the air has been regarded; but never so well illustrated, till of late the Reverend Dr. Hales *made a calculation of it, as shewing itself in his experiments. And many of the changes these actions undergo in irregular cases, offer themselves to confirm our doctrine, and seem to bring us to a juster view of some very considerable diseases, and to provide materials for augmenting our aphoristical maxims. But I shall not further insist upon my own opinion on a subject which I put into your hands to judge of, who will be sure to form your opinion as the evidence and weight of argument shall direct you: therefore I leave it to you to determine how far I have followed* Hippocrates's *example; how far I have been attentive to the most material* phænomena, *and viewed their dependencies. If I have in any degree attained to this, my thanks are due to you who first laid the plan, for pursuing my studies, before me, and recommended* Hippocrates *so warmly for an example, as one well skilled in all the literature of the antient* Greeks, *and animated with their scientifick spirit: permit me therefore to inscribe to you the following Essays, as a small testimonial of my sense of your favours,*

vours, and of my affection. May you live long to reap the native fruits of the useful and delightful ſtudies you have hitherto purſued with ſo much ſucceſs.

O rectam ſinceramque vitam! O dulce otium honeſtumque! ac pene omni negotio pulchrius!

I am moſt heartily your's,

THOMAS SIMSON.

ESSAY I.

Of Muſcular Motion.

CHAP. I.

Of the action of the muſcles, and what ſubjects them to the will.

IN this Eſſay I ſuppoſe what Anatomiſts have diſcovered, concerning the compoſition and make of the muſcles, to be known; and therefore ſhall ſay nothing on that head; but begin to give an account of the motion I propoſe to explain, in ſome inſtances that lead us to a diſtinct view of the queſtion I am to handle; the neglect of which, in philoſophical inquiries, is often the cauſe of great miſtakes and obſcurity.

In that kind of muſcles we call *ſphincters*, we diſtinguiſh three different ſtates they obtain in the body.

 1ſt, Their

1*ſt*, THEIR natural tonic ſtate, or that ſtate they affect and keep at by their natural vigour, when left to themſelves.

2*dly*, A ſtate of diſtenſion beyond their natural tone, always owing to ſome force applied to them.

3*dly*, A ſtate of contraction beyond their common or uſual tonic ſtate; ſometimes produced ſuddenly, by the irritation of ſome *ſtimulus*; or otherways gradually, by their own native force, when ſeldom dilated; from which cauſe I have found the *ſphincter ani* contracted ſo cloſely, that with difficulty it admitted a clyſter-pipe.

AND thus we find in theſe *ſphincters* the ordinary changes elaſtic bodies admit of, *viz.* of being either dilated or contracted beyond their more ordinary ſtate; tho' it is not eaſy to determine what is the middle ſtate in any body, between the firſt degree of extenſion, and the firſt of contraction, or, when a muſcle is in a ſtate wherein we cannot call it extended or contracted. Nor do we ſuppoſe this middle ſtate to be the true tonic ſtate of the muſcle, which always implies ſome degree of contraction, and muſt not only

only in different perſons be ſuppoſed different, according to their conſtitution and ſtrength, but even in different muſcles in the ſame perſon, according as they have been exerciſed or compoſed originally: and therefore, by the true tonic ſtate of the *ſphincter*, or any other muſcle, we do not mean any preciſe degree of contraction, but that ſtate or degree of contraction it keeps moſt eaſily in the preſent ſtate and ſituation of the body.

WE find two cauſes employed to dilate the muſcles.

Firſt, ſome antagoniſt muſcle or muſcles; as the extenſors of the limbs extend, by their operation, the flexors, and *vice verſâ*; and the antagoniſts, every other where, mutually one another.

AND then, again, the hollow muſcles, or *ſphincters*, when not directly provided with antagoniſts, are diſtended by having ſome body driven into their cavity, which acts upon the muſcle like a wedge; as we find thoſe of the *anus* and *veſica* dilated; though many *ſphincters* are dilated by muſcles or muſcular fibres, as that of the mouth

and

and *pupilla*, which therefore are allowed to be antagonifts to them.

Now, whichfoever of thefe two caufes takes place, it is abundantly evident, that they act by drawing or forcing the parts of the mufcle they affect to a greater diftance one from another, and fo lengthen the whole mufcle: And we find that all the mufcles provided with antagonifts, exert themfelves in fuch a manner, that when any one acts upon its neighbour, fo as in the operation to ftretch it out, the one thus employed is contracted and fhortened; as is evident in the arm, which, when folded, has the flexors contracted, while the extenfors are extended: and when the arm is extended, thefe mufcles obtain a contrary ftate; for then the extenfors are contracted, and the flexors ftretched; though in this cafe *Borellus* reckons the extenfors relaxed; as he afferts, *prop.* 139. *de motu anim. part.* 1. where he illuftrates thefe alternate ftates of the mufcles; and infifts further upon it, *prop.* 5. *part.* 2. where he argues, that the mufcles do not act by their own native force, but fome acceffory ftrength fuperadded to them; and, among feveral other reafons, he adds,

Quia

Quia quo magis muſculi & eorum fibræ contrahuntur & decurtantur, eo magis flacceſcunt, & laxæ redduntur machinulæ ex quibus componuntur: videmus enim machinam tunc maximam vim exercere, quando violenter trahitur, diſtenditur elongaturque, ut fides citharæ tenſæ. Where he plainly makes the *decurtatio* to be a *relaxatio*, contrary to the plaineſt obſervations: for in that ſtate in which the *ſphincters* are for ordinary, if we apply any cauſe to ſtretch or diſtend the muſcle, we ſhall find a reſiſtance to the power we apply. And certainly it is by this force the *ſphincters* do their duty; which ſhews, that in that ſtate the parts are firmly knit or compacted together, and require ſome force in order to make them quit, in any meaſure, their intimate coheſion, ſo as to yield to any degree of ſtretching. Indeed, when ſtretched, the force by which thoſe parts act upon one another, becomes greater and more apparent. The greater ſeparation of the parts, while their union is not diſſolved, gives them a greater latitude to act; and makes their ſpring to be more bended for it, as in the bow; but when allowed to act in this ſtate, and,

and, by their action, to recover their more compact and firm ſtate, to reckon then the muſcle relaxed, ſeems not at all proper, except we allow contraction and relaxation to ſignify the ſame thing; whereas a little attention muſt make us ſenſible they differ greatly: for example, in the earth-worm or leech, which, like the muſcles, are now ſtretched, now contracted, how improperly ſhould we ſay, that any of them, in their contracted ſtate, are relaxed, when we ſee their parts furled and knit together with that degree of energy, which reduced them from the more dilated to the more contracted ſtate.

Indeed, if the muſcles, in their contracted ſtate, have any *ſtimulus* applied to them, and, by its irritation, are made to knit and contract their parts cloſer together, than they commonly are by their own energy, and, upon withdrawing the *ſtimulus*, have returned again to their more ordinary ſtate; I would call this laſt action of theirs, whereby they returned, a relaxation; it being ſo, in my opinion, in a very proper ſenſe; and is the only caſe where a degree of relaxation obtains

obtains in a ſtate of health, as far as I can find, the returning from a ſtate of diſtenſion being very different from it, and what we call the contraction of a muſcle.

Having thus illuſtrated the nature of the three different ſtates I find the muſcles capable of, and ſometimes aſſuming, I readily agree with *Borellus*, that the muſcles make no obſervable ſudden contraction, till once by force they have been ſtretched beyond their natural tonic ſtate; as he obſerves in the propoſition laſt cited. But then I cannot agree with him, that the *actio muſculi vitalis non fit vi propria contractiva machinarum fibroſarum*, as he expreſſes it. It is true, the ordinary force they exert is not ſufficient to do all we find them do, to lift and ſupport the great weights we find them engage with. But then, I maintain, they can exert a much greater force, when ſtimulated or irritated, without the acceſſion of more fibres than they had, or any matter to give theſe more ſtrength. All that the *ſtimulus* does, is to make them exert the ſtrength they had. It anſwers to the corded bow which ſtrikes the fiddle-ſtrings, as we ſhall ſhew more fully afterwards,

afterwards, and makes every one of their compounding parts exert themfelves in the production of found; or, if you will, it is like friction to the electrical body, which calls forth its latent powers, and adds nothing but motion to the matter it contained. And this the *ftimulus* cannot do to any purpofe before the mufcular fibres are ftretched, as *Borellus* obferves; and in proportion as they are fo, ftill the more. This ftretching raifes the fpring or elafticity of the fibres, as much as that of the archer's bow is by being bent, and gives them a latitude to contract: and in this cafe the irritation makes the whole elaftic force difcharge itfelf; as letting loofe the ftring by which the bow was kept bent, at once makes the combined force of every particle in the bow fhew itfelf in producing one uniform ftroke or impulfe. And what other advantage can we imagine the mufcles fhould gain by being ftretched, in proportion to which their force increafeth?

Mr. *Cowper* feems to have had a juft fenfe of this doctrine, in treating of the ufe of the oblique mufcles of the eye. He eafily fatisfied himfelf, that the four ftraight mufcles, being

ing much ftronger than the two oblique, would keep themfelves in a contracted ftate when not employed, and thereby occafion the oblique to be kept ftretched to fome degree: fo that, as none of the ftraight exert themfelves in that contracted ftate, wherein they have no latitude to move, he therefore reckons that the ufe of the oblique, is to pull the eye forward by their contraction, for which they are always found ready ftretched, and thus put the four ftraight upon the ftretch; in which cafe, the mind has an opportunity to make any of them act as fhe pleafes, while fhe no way affects them in their contracted ftate.

And how much would it have cleared the doctrine of mufcular motion to us, if he had given the fame ufe to all the antagonift mufcles, which certainly they have? The ftronger in a natural eafy ftate, when not employed, are left contracted; but the weaker antagonift ftretched, which, when brought to contract by the inftigation of the mind, does neceffarily ftretch the ftronger, as we noticed above with *Borellus*; and therefore, in fact, one part of the mufcles of the

body are contracted, and another kept upon the ſtretch; ſo that the mind cannot directly move all, theſe which are already contracted being out of her juriſdiction, but are brought under it by means of their antagoniſts.

We need not then be ſurpriſed, that we cannot move the *ſphincters*, which have no antagoniſts in their ordinary ſtate, which is a ſtate of contraction. This the mind cannot do to any muſcle, in that ſtate, more than to ſuch *ſphincters*; but if we will try her power over them, when dilated, as they are when any thing is paſſing them, then we ſhall find that ſhe can contract them at pleaſure, as ſhe does other muſcles when ſtretched.

How unadviſed then have thoſe people's labours been, who, overlooking the ſtate of the muſcles themſelves, have ſearched for the cauſe of voluntary motion amongſt the obſcure receſſes of the brain? In my apprehenſion, the mind has immediate acceſs to the muſcles and muſcular fibres, and, in producing of motion, affects them after the ſame manner with a *ſtimulus*. No place in children is more ſecure from the influence of the

the mind, than the *uterus* and breafts; for in them thefe parts are not liable to be ftretched; but as in menftruating women they are often on the ftretch, fo then every *ftimulus* and agitation of the mind affects them; and, as they are ftill more ftretched in child-bed, they are then ftill the more eafily affected by the fame caufes. Thus, any violent paffion will put a ftop to the *lochia*; and a drop of cold water falling upon the body in that fituation, will, by the *ftimulus* it occafions, produce the fame effect.

In general, whatever parts are made to contract eafily by the irritation of a *ftimulus*, the fame likewife are eafily contracted by the mind. This is evident in the cafe of the heart; which, with every piece of concern, is made to throb and flutter: nor is there any part, even out of the body, that is more eafily irritated. How then can it be alledged that the heart is exempt from the power of the mind? I own that the mind is very far from having the abfolute direction of its motions: but when we come to fpeak of refpiration, as we fhall then fhew, that this has a great fhare amongft the caufes which promote the mo-

tion

tion of the heart; fo it will be eafily underftood, why this bowel is not wholly in the power of the will: for then it will appear, that refpiration is chiefly carried on by caufes which are no way concerned with the mufcles, and to which the mind has no accefs; and confequently that the heart fo much influenced by the refpiration, cannot be altogether under the direction of the mind, no more than the refpiration itfelf.

Thus it is evident, that the mind can act upon every mufcle, and not command them altogether, when under the power of other caufes; and that they are as eafily affected by the mind, as by any *ftimulus*. The being dilated, is the evident preparation in the mufcles, which makes them fo readily anfwer to any irritation, whether from the mind or fome material *ftimulus*.

And this obfervation lets us fee, why moft of the mufcles are provided with antagonifts; for, the ftronger mufcles keeping the weaker always in fome meafure ftretched, by this means we have the command of every member that is neceffary for us to employ: and the whole body is a curious machine, moft

artificially

artificially provided with pulleys, whereby to guide and direct its motions; all of them in ſo happy and advantageous a ſituation, that the mind, by its nod, makes them exert their ſtrength, as well as any, whatever, *ſtimulus.*

And what more than this diſpoſition of the muſcles can be judged requiſite in accounting for voluntary motion? In any inſtance where the mind employs the members of the body, nothing elſe appears neceſſary. Thus, as the *ſtimulus* increaſes, ſo does the force of the machine: for as the weight is which is ſuſtained by the muſcles, ſo is the *ſtimulus*; and as is the *ſtimulus*, ſo is the contraction of the muſcles; and conſequently the force or ſtrength of their action (which is no other but the reacting of the ſtretched parts in proportion to their being ſtimulated, which law they have in common with every elaſtic body): ſo that the force of the machine increaſing with the weight, the mind has no more to do, to raiſe a greater weight, by means of the muſcles, than a ſmaller; and therefore there is no neceſſity to ſuppoſe any new matter to accede to the muſcles to accompliſh this.

But the force whereby the muscles exert themselves, not only arises from the degree to which they are stretched, or what may be called their latitude of contraction, and from the degree of irritation, but from the natural texture and firmness of the parts. Thus *Richard Goy*, whom *Baglivi* gives account of, in his letter to *Peter Hotton*, had rather the strength of a horse than a man: and whence came this? *Baglivi* tells us his limbs felt like marble or steel; he further observes, that the fibres of a lioness he dissected were gross like spun fiddle-strings, and would scarce yield when pulled; whence he justly accounts for their strength; and herein agrees with the judicious *Van Swieten*, who, in his commentary upon *Boerhaave*'s articles on the robust fibres, says, "*quo firmior est fabrica, et* "*major elasticitas vasorum laterum, eo validior* "*est nixus.*"

The muscles, then, in a live body, are nervous elastic pulleys; and according as they are more or less elastic,—as they are more or less firm and compact,—as they are more or less stretched,—and as they are more or less

irritated

irritated by ſome proper *ſtimulus*, do always act with more or leſs vigour.

The elaſticity of the muſcles is indeed the foundation of all their force. But, in explaining muſcular motion, it ſeems no more neceſſary to inquire into the cauſe of this elaſticity, than in explaining the regular and uniform motion of a watch; which takes its firſt movements from the ſpring, though its wheels and balance muſt regulate them: nor is it neceſſary, in our comments, that we ſee whence this elaſticity ariſeth in the muſcles, more than how the wool firſt gained it, of which they make *Duncaſter* hoſe. The workman finds that the wool has originally a great deal of it; that, by twiſting it, it gains more, and ſtill more by the particular form in which it is wrought, though he never conſiders how it is acquired in any of the proceſſes.

And what a lame account would he give of the firmneſs and energy of his work, ſhould he tell us its elaſticity comes from the ſpirits of the ſheep, though perhaps the wool, firſt nouriſhed by theſe, had its firſt energy from them; which, at the ſame time, we are by no means able to explain. So that, I

ſay,

fay, it feems altogether needlefs to account for the elafticity of the mufcles, or to trace how they have acquired fuch a power of being ftretched, and of rebounding with more or lefs force as they are ftimulated. This is a power we find attending matter in a great many different forms, and what we ourfelves truft to in the compofition of many machines, whofe nature will not change, whatever account we give of elafticity. And thus we find whether Dr. *Stewart*'s account of elafticity, or *Bellini*'s fhould hold, that it would be the fame as to our account of mufcular motion.

Dr. *Stewart*, in his lectures on mufcular motion, reckons, that, by ftretching any elaftic body, the fluid particles environed with the folid parts, from being fpherical, are compreffed, and made fpheroidical againft their natural inclinations; and that, as foon as the compelling force is fufpended, their natural powers exert themfelves, and reduce the compreffed fluid to the fpherical form again; and, with them, the diftended folids regain their ordinary compactnefs. *Bellini* and *Sanctorinus* fuppofed the action to depend upon the folids themfelves; thefe, by their account, being

being ſo diſpoſed that their ſmaller particles can ſlide over one another, without loſing altogether their contact; and that, in this caſe, they are under great reſtraint, by the influence of the parts they left exerting that attraction, by which the particles of bodies are kept in union; and, therefore, when left at liberty, they bounce back to their place again, or, as *Lucretius* has it,

Se ipſe in ſe trahere, & parteis conducere in unum.

In both theſe accounts, we find the elaſtic power is ſuppoſed lurking in the parts of which the bodies themſelves are compoſed; and that it is the ſtretching whence they gain the advantage that enables them to exert themſelves, without the acceſſion of any new matter to join them in the operation. And as we have ſhewn that the muſcles undergo ſuch a preparation, before they exert their powers, we reckon we have eſtabliſhed the fact, which is the true foundation of muſcular motion; and this fact gives us ſo clear a notion of the condition which ſubjects the muſcles to the will, that it adds not a little to the beauty of our theory, which, we hope,

ſhall be increaſed by what we have to obſerve on the action of *ſtimuli* and the mind; to which, as a neceſſary preliminary, we prefix the following chapter.

In the mean time, I ſhall put an end to this, by obſerving, that it muſt follow from the antagoniſt poſition of the muſcles, that, in their greater ſtate of indolence, the ſtronger muſcles can only keep contracted by a degree of contraction equal to that whereby it exceeds the weaker. Nevertheleſs, this ſtate of indolence is not what we chuſe to keep the muſcles at, when we chuſe to reſt after fatigue: for then we keep thoſe contracted, which under the fatigue had been moſt on the ſtretch. And thus, as *Borellus* obſerves, *prop.* 143. *part.* 1. when we are obliged to ſtand long, we do it ſometimes on one foot only, which eaſes the muſcles long on the ſtretch: and we ſleep with legs and arms folded, after having them in another poſture through the day; ſo that ſleep rather allows a viciſſitude to the active muſcles, than a ſtate of perfect reſt to all. But the heart continues well, or ſuffers no fatigue, under a perpetual motion; becauſe while moving, it

it is as much in the contracted ftate as the diftended; and therefore recruits by moments, what the others do by nights; and thus care is taken that the heart fhould not be too long on the ftretch at a time; which *Æfop* long fince found to be fatal to elaftic bodies.

CHAP. II.

Of the connexion amongft the mufcles, mufcular fibres, and membranes by which moft of the irregular motions in the body are propagated.

THE nerves having been depended on as the great inftruments of fenfe and motion, Phyfiologifts, in accounting how pain, and a variety of motions, fpread themfelves from place to place, have contented themfelves with pointing out fome alliance or other amongft the nerves diftributed to thefe different places; tho' they never took the trouble to know, what the connexion is between the fibres of the fame pair of nerves, which fhould make two places fuffer at once from

from it; or to determine why only two or three, and not all the places ſerved by theſe nerves, ſuffered at once when any of its branches were attacked. Perhaps, if the Phyſiologiſts had carried their ſpeculations a little further, they would not have been ſo well pleaſed with their theory; ſince the riſe of the nerves, and the different *fibrillæ* making them up, is very obſcure, and the ſource of the bundles we call pairs, ſeems often as various as the branches themſelves; which muſt render it not ſo eaſy to find where the connexion ſhould ly: nor would it be leſs difficult to explain how motion of any kind ſhould be propagated along parts the leaſt elaſtic and moveable. Appriſed therefore of this, one ought to try, if there are any more probable means by which ſuch ſympathies may be eſtabliſhed. The Anatomiſt is the proper perſon to guide us here, as in all our ſearches into the animal œconomy; and I am confident, that what he has already laid before us, would be an advantageous thread to conduct us, did we carefully attend to it.

Thus we find, that all the membranes of the

the brain are not only cloſely connected together, but that the chief of them, the *dura mater*, with all its various proceſſes, are in the moſt ſtretched ſtate; as Mr. *Winſlow* obſerves, The large proceſs of the *dura mater*, the *falx*, which, for ſome depth, divides the *cerebrum* into two lateral portions, is attached for ſome length at its poſterior end, croſs the diaphragm (which ſeparates between the *cerebrum* and the *cerebellum*, and involves the upper ſurface of this laſt part as a cover), and keeps it ſo ſtretched, that it can ſupport a conſiderable weight without being depreſſed; but flattens immediately upon the *falx* being cut through; as this turns looſe upon ſlitting the diaphragm. And as theſe parts keep one another quite ſtretched, ſo likewiſe they keep ſtretched the whole *dura mater*, whoſe proceſſes they are; and all its other proceſſes, not only running variouſly through the ſubſtance of the brain, but by a variety of paſſages to the external parts of the head: ſo that by them the whole face, ears, and eyes, &c. are greatly affected, or made more or leſs ſtretched, though, by their own ſtructure, they are greatly ſo; as appears by ſlitting

ting any part of them in a live animal; for the wound in that caſe becomes very wide, and gapes, and thereby diſcovers how much their parts contract when left at liberty: and the ſame happens all over the ſurface of the body; ſo that every part thereof is ſtretched in a natural ſtate. And as it receives portions from all the neighbouring parts, which contribute not a little to its compoſition, we cannot but be ſenſible, that this general medium of the ſkin is greatly fitted for making a ſympathy amongſt all the parts of the body.

Now, to form a notion, how and what parts are attached to the ſkin, we muſt examine the obſervations on that head: in making which, the accurate Anatomiſt *Steno* has been very diligent, in his treatiſe *De piſce carcharia dicto.* He ſays, *Ex demonſtrata tendinum in cute inſertione evidens eſt, quid de membrana adipoſa, de membrana communi muſculorum ſtatuendum; voluere plerique eſſe hæc involucra communia corporis, ſed nec panniculus carnoſus totum corpus inveſtit cum id generis cutanei muſculi, qui huic pannulo occaſionem dedere, tantum in quibuſdam locis conſpicantur; nec membrana adipoſa aliud eſt, quàm adipis col-*

lectio

lectio ſita inter prædictas tendineas fibras à muſculis in cutem abeuntes; nec membrana muſculorum, communis dicta, unica eſt membrana, ſed ubique tendinum à diverſis muſculis prodeuntium membranoſa expanſio, unde fibræ in cutem recedunt: patet inde quid de aliis multis membranis ſtatuendum, ſcilicet non ſemper eſſe illas tunicas partibus vicinis per immediatum contactum firmiter adherentes, ſed eſſe illas perſæpè iiſdem ferè continuas ob fibrarum à tunicis in partes vicinas, aut à partibus vicinis in tunicas tranſitum, &c.

This we ſhall exemplify afterwards, in another treatiſe, from ſome of the beſt and more modern authors, where we treat of the coats of the eye: and as it is now fully ſhown, that the *tunica adipoſa*, as it ſpreads with the ſkin, ſends off proceſſes, not only between every diſtinct muſcle, but round every fibre of a muſcle, ſo it is manifeſt, from *Steno*'s obſervations, that the tendinous expanſions of the muſcles ſpread with it, and are the conſtituent parts of it: and thus through the whole body, there is intermixed with very ſmall interſtices one continued piece of network, firm and upon the ſtretch, made up of tendinous

tendinous fibres, and closely connected with the skin.

The diligent *Wepfer* found a like connexion in tracing the course of the nerves, as we see in his 8th chapter *de cicuta aquatica*; where he has the following paradoxes. *Primum est ventriculi & intestinorum fibras, addo etiam cordis & omnium musculorum nihil nisi nervos esse aut proximè ad illorum naturam accedere; certè si quis persequatur cum solertia quadam nervos, musculos subeuntes observabit nerveas fibrillas arctissimè uniri, in unum corpus coalescere. Et licet nervus, musculum transiens, non omnis in illius fibras impendatur; id tamen in vicinis musculis fit, atque eo usque progrediuntur, donec tandem in membranas, adæquatum tactûs organum, absumantur, hacque ratione terminentur.* Which I reckon will be allowed the same connexion that *Steno* attributed to the tendinous fibres; as these terms, of *tendinous* and *nervous* fibres, are very promiscuously used by Anatomists. And what *Wepfer* immediately adds, confirms our assertion. *Non hoc cuiquam absurdum videatur, quod nervi corpora mollia; minusque tenacia sunt præterea minuta, ut hanc ob causam impossibile est tot fibras*

bras in tota corporis fabrica conſtituere; molles eſſe nervos intra ſpinalem medullam, ut cæteros quatuor ſenſibus inſervientes præteream contentos; indeque elabentes aliquouſque, ultro fateor, at paulo ulterius progreſſi non ſolum tenaciores, ſed & craſſiores evadunt, alicubi ganglia pro majore robore, indultu naturæ beneficæ aſciſcunt. By this obſervation, it would ſeem, that the nerves are not perfected by the brain, but that they receive additions and a different mould and tempering before they are wrought in amongſt the other parts, and aſſume more the appearance of fleſhy fibres, than they had originally; and thus are gradually aſſimulated to the other parts of the body, amongſt which they are loſt; and, as they paſs from part to part, carry along with them portions of the parts thus touched at; and therefore theſe compound fibres may be termed tendinous or nervous, as we pleaſe; only let us ſufficiently attend to theſe alliances and connexions, and conſider the intimate union that is cauſed thereby amongſt the parts; and we ſhall find a better handle whereby to explain their ſympathies, than from their having branches from the ſame pair of nerves.

THIS author, a little before, in the ſame chapter, had given many other inſtances of remarkable connexions. *Gula*, ſays he, *non ita libere tranſit per diaphragma, quin potius undique ſuperne gulæ, prope ventriculum mediante membrana, cum peritonæo communi connectitur; inſuper à diaphragmate reliquo ubi gula illud permeat, filamenta et membranæ nerveæ arctiſſimè uniuntur, et ulterius aliquoſque exporriguntur, atque etiam fibris ventriculi rectis potiſſimum coaleſcunt.*

Lanciſius, in his diſſection of the heart, finds that its proper membrane is nothing but a piece of cloſs web-work, woven from the detachments which the fibrous parts make; and therefore calls it *tendinea*, as if it were a common tendon to the whole. But not only does the heart ſend detachments through its own cover, but along the blood-veſſels ariſing from it; and thus the ſtricteſt union is amongſt all the parts of the body, and no place can be violently affected, but the neighbouring parts muſt be variouſly teaſed and rack'd by it. And thus, if you touch one part of the membrane, the whole is agitated in every fibre: but, beſides this general con-

nexion,

nexion, particular parts have particular diſpoſitions for affecting the neighbouring parts.

No Anatomiſt is ignorant of the manner the membrane of the ear is ſtretched for vibration, by a fixed *vectis* and muſcles to manage it, as are the other bones which at laſt terminate at the membrane of the *foramen ovale*; whence a vibration is carried through the *labyrinth*, as we ſhall afterwards ſhew. And *Valſalva* ſhews, that the cartilaginous parts of the *euſtachian* tube, which is kept fix'd while the muſcle of the greater proceſs of the hammer is on the ſtretch, becomes moveable upon that muſcle's contracting, when left at liberty, by the *membrana tympani* being preſſed in by the air; and upon that, his new tuberian muſcle, hitherto upon the ſtretch, acting upon the cartilage, dilates the tube by its contraction; and thus the moment the external membrane is touched, the tube gapes, and gives way to the vibrations of the internal air, to increaſe their force, and make them more diſtinct.

Nor has Mr. *Ferrein*, in the Memoirs of the *Paris* academy for the year 1741, made it leſs evident, that there are two tendinous

chords

chords along the felvage of the *glottis*, which the actions of the mufcles and cartilages of the *larynx* guide and tune, by whofe vibrations the voice is formed in all animals: the mufcles which raife and fpread the *velum palatinum* are always on the ftretch, till the tongue is drawn back in fwallowing; and then of neceffity they muft contract, and the more that the *uvula* is irritated by the *bolus*.

And *Sanctorinus* (art. 17. chap. xi. of his obfervations) finding, that by blowing air into the uterine tubes, their loofe extremity turned towards the *ovarium*, made no improbable conjecture, that a *ftimulus* of the veffels turgid on the aphrodifiac tranfactions, would have the fame effect, efpecially as he had difcovered fibres well fitted for the operation.

The animal machine, then, is fo compofed, that there is fcarce a flexible fibre in it that has not either a fufficient latitude to contract, or that cannot be brought into that ftate immediately by the action of fuch as have a latitude; and then thefe fibres have fuch a communication, that it is eafy to trace their dependence one upon another, from head to foot, by their immediate connexions:

and

and if to this we ſhall add the power of *ſti-muli* upon them, we muſt be ſenſible that there is not a more moveable machine in the univerſe than the animal body. And this we propoſe, from inſtances, to illuſtrate in the following chapter.

CHAP. III.

Of the effects of different ſtimuli *on the animal fibres as we have deſcribed them.*

AS there is ſcarce an inſtance of any kind of matter but what can propagate ſound; ſo we may conclude, that there is ſcarce any but what has more or leſs vibration when touched advantageouſly. Mr *Boyle*, in his treatiſe of languid motions, obſerves, that there are ſome bodies, ſuch as bell-metal, which, when put into certain forms, cannot be touched without vibrating or ſounding more or leſs; as he found in a ſtrong bell, which was heard ſounding when touched with the point of a pin only; and in other caſes

caſes that ſound was propagated by very unpromiſing mediums, as he found by a ſmall ſtriking watch, whoſe ſound was heard and felt through a gold caſe, the cloſeſt of all metals, a ſhagreen caſe, and the cloth of his pocket, or whatever elſe interveened between that and his ear: and how much more are the animal fibres fitted for ſuch vibrations and the communication of ſuch motions?

Nor are there experiments wanting to ſhew it. Apply a vibrating fork to the teeth, crown of the head, or brow, and the ear ſhall be greatly ſenſible of it; ſo that bones, membranes, and variety of other animal ſubſtances, can be touched ſo as to propagate a vibration. And according as they vibrate, they raiſe an infinity of different ſenſations; of taſtes, ſmells, ſounds, colours, *&c.* nor is it to be doubted that every part receives a different ſhock, as the twitching them varies. Nor is the ſmart of the ſhock, or the degree to which it extends itſelf, proportioned to the force or violence with which the cauſe acts on the place to which it is applied; for *Wepfer*, in the eighth chapter *de cicuta*, obſerves, that many cancerous ſores, which

conſume

conſume all about them, produce neither ſpaſm, nor convulſion, nor any great agitation amongſt the parts; of which we have an inſtance in the caſe of Mr. *Kay*, in the *Philoſoph. Tranſact.* which, beginning in his face, conſumed the eye, deſtroyed a great part of the *os frontis*, *dura mater*, and the whole of the brain, without cauſing any ſpaſm or diſturbance in the other parts; tho' ſuch an effect is ſometimes produced by the gentle titillation of a feather, or the tickling of the ſmooth fingers upon the ſound parts of the body; and Mr. *Boyle* tells us, that he was threatened with convulſions from the hairs of his peruke lying on his face when he could not move his hands.

THERE is then a certain way of teaſing the well adjuſted fibres, which produces the ſpaſms, and makes the convulſions ſpread. And in this the energy of *Wepfer*'s hemlocks ſeems to have conſiſted: for, at the time they cauſed the moſt terrible ſpaſms and convulſions through the different quarters of the body, they did not act in the ſtomach with ſo much violence as the tobacco did; which produced a vomiting, and threw out the

roots.

roots. We may compare their singular virtue to that of the small stones which break the *Bononian* glasses, though gently dropt into them, when things much rougher and heavier have no such effect, nor yet the severest blows. *Vid. Institut. Bonon. tom.* 2. A very simple case occurred to me, to illustrate this doctrine. An old woman, who had one of the tusks of her upper jaw hanging loose, by a single fibre, was struck to distraction with the twitches it gave the neighbouring parts; for whatever touched the tooth, immediately struck her in upon the nose; whence a violent pain ran up its ridge, then up the brow, over the middle of the head, down the neck and spinal processes of the back, till it came near the last of them; when the pain was so excessive, that it confounded all her senses, and left her for a moment in a kind of swoon. This had happened for a month, as often as the tooth was touched, till I was sent for; when, by snipping the fibre, I secured her against the process; wherein the spirits could have no share whilst the pain ran cross so many different parts of the body; several ways strictly connected,

though

though by no alliance of nerves. Mr. *Reaumer*'s account of the ſtriking fibres of the *torpedo*, ſhews how much they are fitted to cauſe vibration; each of them is divided into ſo many ſmall ſections by parallel membranes; between which lies a pulpy elaſtic matter; ſo that when the longitudinal muſcular fibres, making up the ſides of the compound fibre, contract, the pulpy matter is compreſſed, and thus prepared for action; which immediately takes place on the contraction being ſuſpended; for then the parts compreſſed bounce out with ſuch a ſmart ſhock upon the finger touching it, that at once the pain flies up the arm a good length, and cauſes a moſt direful ſenſation, and terrible force, on the chain of particles compoſing the muſcular fibres; ſo that, for ſome time, they are benumb'd, and in a manner deprived of their elaſticity; not unlike what happens from the ſhock of electricity, which ſtrikes the member meeting the flying electric matter, either by itſelf, or combining with thoſe ſulphureous emanations, perpetually riſing from the body. But, however that may be, it is plain, the manner of the

ſhock is that which produces the ſmart upon the joints, where the muſcles which are agitated by the ſhock are inſerted. What is it that makes a perſon with ſhattered bones, or even fibres ruffled by wounds, not only gall'd, when lifted, or roughly handled, but that they cannot bear the vibration of the air, from the diſcharge of cannon, or otherwiſe? as Mr. *Boyle* obſerves in the treatiſe mentioned, Nothing certainly is more ſuſceptible of motions of all kinds, than the fibrous parts of our body, tun'd and ſtretched for that purpoſe, and which occaſionally meet with a great many odd diſpoſitions; but none more remarkable than in the caſe *Van Swieten* mentions, which I ſhall ſet down in his own words, from his *Comment.* on *Boerhaave's* Aphoriſ. *vol.* 1. *p.* 35. *Memini me curaſſe nobilem puellam qua in nervoſo genere nobiliorem nunquam vidi: à minimo ſono, à lumine vividiori convellebatur illico, miros motus cum lacerationis ſenſu in abdomine ſentiens; nec ferulacæi ſucci, nec ſalutare in his caſibus, caſtorei virus proderant, dum autem faſciis, crura, femora, totum abdomen ad mammas uſque firmabantur, remiſit ſtatim moleſtum malum; & datis*

tis dein idoneis remediis, convaluit: per menſes tamen ſic, inſtar mummæ Ægyptiacæ, ferè faſciis circumductis vixit; haud invita cum illico tantum inde ſentiret ſolamen. Now, can we ſuppoſe that theſe bandages interrupted any flow of ſpirits by compreſſing the nerves; in which caſe they would have done more ill than good, ſince it would have interrupted both ſenſe and motion at the ſame time? But, that they could prevent the ſmall irritation of light or ſound from ſpreading the fibrous agitations in a body very ſuſceptible of them, without any bad effect, is very conſonant to what happens in other vibrating bodies, whoſe vibration is ſtopt by the interpoſition of any other body preſſing upon them. We have many inſtances of ſpreading agitations from the extremities all over the body. Who is it that has not found ſmall blaſts of cold air on his legs, when warm, immediately raiſing ſpaſms or gripes in the belly? and their continuance makes the inteſtines exert themſelves more, with the muſcles of the abdomen, than the ſtrongeſt purges can do? as we find by Dr. *Stevenſon*'s obſervations in his paper in the 6th volume of *Medical Eſſays.*

Galen,

Galen, and ſeveral other more modern authors, have obſerved remarkable ſpaſms riſing from the very toes to the ſeveral members of the body; and have had obſervable ſucceſs in diverting them by ligatures and iſſues near to the different ſources; as *Tulpius*, in one ariſing from the big-toe, *chap.* 2. *lib.* 4. and Dr. *Short*, *Medical Eſſays*, *vol.* 4. from the leg, which had ſubſiſted for a dozen of years together, and which he cured by cutting a ſmall cartilaginous tumour from a nerve, as he reckons, ſeated pretty deep. I know in theſe caſes it is ordinary with *Tulpius*, to reckon that, though the ſpaſms riſe from the under parts, and ſpread up to the higher, yet moſt of them are to be derived from the brain. But what is the neceſſity of this, when we find that they can ſpread from parts at ſuch a diſtance up to the brain? Can we not allow, as in the caſe I mentioned from the tooth, that they ſpread from place to place, as they ly contiguous, and are tun'd for it, till they ſpread over the whole body, and even penetrate to every veſſel; ſince we know a connexion amongſt the parts favouring this, according to what we obſerved in

the former chapter. The vapours from the part mentioned by *Tulpius* are quite fancied, and could have no place in the caſe of the tooth, or that mentioned by Dr. *Short*; both of which ſhew, that it is not the deſtruction of the nerve that is ſo much to be purſued in theſe caſes, (as *Van Swieten* would have it, *Comment. in aphoriſm.* 234. *Boerhaave)*, as the taking away the *ſtimulus*: for in the caſe *Van Swieten* ſpeaks of, the convulſions ſpread over the whole body, as ſoon as the irritation reached the region of the heart; and, in the caſe of the tooth, it paſſed the head to the back before the ſwooning. *Wepfer* is very explicit on this head, about the middle of the 8th chapter *de cicuta*; where he ſays, *Quidam ut hanc compaſſionem (nervorum ſcilicet) credulis obtrudant, maximè in convulſione univerſali ſeu epilepſia, partium diſtantiorum læſione ſubſequente, præviam in nervorum origine diſpoſitionem & apparatum cauſæ morbificæ comminiſcuntur; quidam inde aliquid vitioſi à parte ægra cerebro tranſmitti opinantur; verum citra apparatum morbificum, circa originem nervorum, epilepſiam excitari aliquando hinc manifeſtum ſit, quod ſæpe hac corripiantur, quoad cerebrum & cerebellum*

cerebellum ſaniſſimi; ſic adoritur illa quoſdam à punctura nervorum, morſu viperarum; infantes corrupto lacte & pultibus in ventriculo & inteſtinis; eandem excitant quoque lumbrici, venena quædam in ventriculo ſubſiſtentia, nec ejus pomæria egreſſa: deinde illa ſæpe tollitur cauſa morbifica ex parte primariò affecta ſublata, nullo vel exiguo ad cerebri roborationem habito reſpectu; vel medicamentis præcipuè ad illius curationem directis. Novi juvenem quendam ruſticum ab epilepſia ſatis truculenta vindicatum fuiſſe, à veſicatorio toti pedis dorſo applicato. Unde ſymptoma hoc tragœdiam ordiri perſenſit. And, after ſome further examples, concludes, *Communicatio cauſæ morbificæ, ejuſque ad cerebrum tranſmiſſio in multorum ore eſt, pleriſque de viis & ratione qua illuc tranſportetur, non uſque adeo ſollicitis.*

This whole chapter of *Wepfer*'s is a true anatomical explication of what we are upon, and confirms greatly, that there is ſcarcely a part of the body whence an univerſal diſturbance may not ariſe; and practical authors abound with examples, tho' often not ſufficiently attended to; whilſt the head is the part only regarded in the cure, and renders the cure very

very uncertain: whereas we find a well-placed bliſter, bandage, or inciſion, to compoſe the greateſt diſturbances. The truth is, that often the greateſt ſeverity of the ſcene, does not appear at the ſeat of the cauſe, but in ſome neighbouring part more ſuſceptible of diſorder; as it is often in the gravel, where the ſtomach and inteſtines ſeem moſt to be affected, and often carry the inveſtigator's attention from the true cauſe. I was called to an old Gentleman ſubject to colicks for thirty years, but who never was ſuſpected of the gravel, till I ſatisfied myſelf this was the caſe, from ſome leſs obſervable ſymptoms, and managed him accordingly the two laſt years of his life; though a violent fit at length carried him off, in an advanced age. On opening him, for ſatisfaction to the friends, we got a ſtone of 4 ounces in the kidney, worn down to a membrane; tho' no diſorder had ever appeared about the urinary paſſages. On *November* 2. 1748, I was called to a perſon under one of the moſt moving caſes I ever was concerned in: A young Lady, in the night-time, was wakened by a ſlight touch of a colick; but then a tickling harſh cough

took

took place, which made her force her breathing with the moft violent concuffion; and continued fo, till convulfions fpread themfelves over every part of the body, and in turns affected them all; fo that there was not a finger or toe, but was twifted and agitated to fuch a degree, that fhe required feveral people to fecure her from deftroying herfelf under the force. During two months we were fure fhe had not fwallowed four ounces of any thing; for the moment it touch'd her tongue, fhe was convulfed and toffed, till fhe fwooned away; nor had fhe any reft all that time, except fome momentary naps, fitting and fupported by her friends; nor for fix months more got fhe any thing but fpoonfuls of fome weak drink, and that feldom without being thrown into the fit; till at length fhe began to pafs great quantities of gravel of the fofter chalky form; few of them any thing fmooth in the furface, but look'd like the fragments of a large ftone that had been beat in pieces with the ftroke of a hammer; for fome of it appeared like coarfe oat-meal, though a great deal of it was as big as fmall peafe; and, together with

thefe,

theſe, ſhe paſſed a kind of earthy clay, which ſpread like plaiſter on the paper wherein it was put. This continued for ſome weeks, and ſhe grew daily better, having ſome days interval, and quite free of the fits; which to me gave a full view of what had ſo long toſſed her. What was obſervable in her caſe was the apparent changes the ſeat of her trouble took; for ſometimes the cough ceaſing, ſhe had only contractions in her gullet, which threatened to ſuffocate her; and when theſe urged ſeverely, ſhe would have pointed with her finger to her arm; ſhe wanted to be bled, and, the moment the lancet pierced the ſkin, ſhe was relieved; as we had occaſion to ſee by repeated inſtances. At other times, it took its ſeat at the ſtomach with the moſt terrible pain at the *cardia*, and vomiting; which never ceaſed, till the ſevere cough urged her again: ſome time after, it ſeized her ſide, ſo that it gave her the utmoſt pain, and threatened ſuffocation. I applied a bliſter; and on this it returned to her throat again; nor left her till the lancet was in her arm. Now, what change in the ſpirits could the putting the lancet in her arm make,

 that,

that, in the ſame moment, her gullet ſhould be relieved thereby? or what change in them did the bliſter on the ſide produce? If it ſhould be demanded, what connexion between the arm and the gullet? I anſwer, that, in perſons with ſuch moveable fibres, when they are running together into ſpaſms at any one point, by twitching them in another, the courſe comes that way, and diverts the pain from the other point: and thus ſuch people have the moſt quick and ſudden ſallies of pains, now in one part, now in another; but the gullet ſeems to be a favourite place, where they frequently centre from every corner. A Gentleman of my acquaintance, greatly ſubject to theſe flying ſpaſms, uſes to have the attack on the *fauces*, *larynx*, and *pharynx*, ſo ſeverely, that he alarms all about him, with a fear of being ſuffocated; blooding generally broke the force of it, but left him ſo weak, for a very long time, that he ſhunned it as much as poſſible; and then trying volatiles of all kinds, the moment they touched his jaws, his diſeaſe was worſe. After theſe obſervations, I took another method. I kept him ſitting in the eaſieſt po-

ſture

ſture he could chuſe, and did not allow him to move hand or foot, or ſo much as his lip: the trouble wrought down to his feet, and left him ſooner, though it was not leſs ſevere, than what it had been in moſt of his fits. I gave orders conform to *Van Swieten*'s method, who kept all the parts bandaged, to prevent theſe ſallies.

I am not ſurpriſed, conſidering the quickneſs with which theſe attacks are made upon one place after another, that ſome ſtrange ſallies of the ſpirits were ſuſpected for it, by *Willis* and *Sydenham*, and moſt of the Phyſicians of this age; though I think it is more natural to ſuſpect, with *Tulpius*, and many others, that certain vapours made the ſhock; eſpecially when the progreſs was from below upwards, as often happens. But, when the connexion and diſpoſition of the fibres are conſidered, and how eaſily they are irritated in ſome caſes, an attention to thoſe ſeems to give much greater ſatisfaction on the head. And thus in my graveliſh patient, who was of a delicate make, it will be eaſily allowed that ſuch a collection in her kidneys was a terrible *ſtimulus* in ſuch a tun'd machine; though

though ſhe had not time or thought left her to attend to the progreſs her trouble made; her ſenſes being quite ſuppreſſed in the cataſtrophe. But in other caſes, where the perſons are not ſo quickly ſtruck, they obſerve the progreſs diſtinctly; as *Van Swieten* deſcribes, in § 234. *aphor.* in a caſe he ſaw, and has often occurred, as we formerly obſerved; two of which I myſelf witneſſed: *In digito majori*, ſays he, *pedis ſentitur titillatio quædam, ac ſi formicæ reperent per partem; aſcendit ille motus per crus, fœmur, abdomen, ad præcordia uſquè; tunc mox cadit convulſus toto corpore.* And to confirm the courſe is this way, he obſerves, with thoſe we formerly cited, that the progreſs is ſtopped by ligatures. Can any examples prove more clearly that the brain or nerves are no way here concerned? That convulſions ariſe likewiſe from the brain, I am fully ſatisfied: but then I am no leſs, that it is after the ſame manner that they ariſe from theſe lower parts. The fibres, which are greatly on the ſtretch here, as we have deſcribed them in the former chapter, allow to be eaſily touched, and muſt greatly propagate

their

their vibrations; which *Baglivi* has confirmed by experiments, *de fibra motrice*, chap. v. *Si dura mater à dextra pungeretur in omnibus ferè partibus, convulfivi motus excitabantur, in ea præcipuè vehementiffimè in qua ipfa pungebatur; fic etiam fi pungeretur à leva: generaliter tamen labefacto poft meningis puncturam tono, confufio incredibilis in partibus omnibus infernis, tam fentientibus quàm fe moventibus nafcebatur, primò quidem in capite, deinde in reliquis.* And thence, a little after he concludes; *Inde demum convulfiones, quæ in hominibus graviter capite vulneratis excitantur, in corporis partibus quæ directè vulneri refpondent*: fo that the convulfions, from irritation at the brain, follow the courfe of the membranes from the part affected; whereas in palfies, arifing from contufions in the brain, the paralytic parts are on the other fide, from the contufion or fracture; as innumerable inftances fhew; which is owing to the nerves croffing the brain, in order to make their *exit* in an eafier and ftraighter courfe. The palfy, then, deprives the parts of their nourifhment, by the injury done the nerves. But convulfions are immediately raifed

ſed from irritation of the membranous fibres upon the ſtretch; and as at one time ſome fibres may be more on the ſtretch than others, ſo a *ſtimulus*, at different times, muſt ſhew its force in different courſes; and thus it is, the *calculus* in the kidney, *ureter*, or bladder, does not make the pain ſpread always after the ſame manner, but according as the fibres are diſpoſed at the time; as the fiddle, which played on, only moves the one tuned uniſon with it, though many others are equally expoſed to its influences.

There is nothing more frequent, among our practical obſervations, than caſes where contuſions of the head produce vomiting, and again, where diſorders of the ſtomach produce diſorders of the head. This I know is ordinarily accounted for from ſome correſpondence amongſt the nerves going to the ſtomach, and thoſe reflected to the *dura mater*. But how much more rationally it is accounted for upon my principles, ſeems pretty manifeſt. That there is a conſtant courſe of fibres from the ſtomach up the gullet, and over all the *fauces*, *membrana celluloſa* ariſing thence, and ſpreading to the muſcles of the face,

face, ſockets of the eyes, and *dura mater* as well as to the *pericranium* externally, is uncontefted; nor are any parts more upon the ſtretch than the *dura mater* and its proceſſes: ſo that we cannot be ſurpriſed to find that the firſt motions to vomit are accompanied with a remarkable vertiginous confuſion, while the medicine has been but a ſhort time in the ſtomach. Many who are more eaſily affected in the ſtomach, have this confuſion from weaker warm drinks, as tea, eſpecially with honey, which is very apt to fret the ſtomach and inteſtines; as I found in a valetudinary Gentleman, who, going into his chaiſe, after a breakfaſt of ſuch things, turned very uneaſy in it, from the *vertigo*. I being called, and inquiring into his breakfaſt, eaſily accounted for the diſorder, and ſecured him againſt a return, by changing his tea for coffee without honey. Some people are the ſame way affected from bile in their ſtomach, or even an empty ſtomach, when their fibres are very bare and expoſed: and hence the charm *Hoffman* makes uſe of for ſuch as are ſubject to it, of eating a little bread and butter before they riſe in the morning, which I have

known

known uſed to good purpoſe. But the ſtronger collections of bile are ſometimes able to produce epileptic fits; of this, in my diſſertations, I gave an inſtance, where the fit was preceded by an obſervable *vertigo*; though at that time I imagined the bile immediately affected the nerves themſelves; but the nauſeouſneſs ſpreading through the gullet to the jaws, diſcovers fully the progreſs, as the remedy ſhews the ſeat of the *ſtimulus*; contuſions and lacerations of the *pericranium* and *dura mater*, ſpread their diſorders again to the ſtomach, which ſettle upon fomenting the parts irritated, as we find in our daily practice: and of which *Wepfer* has given inſtances amongſt the practical obſervations; and *Ruyſch* in his anatomical obſervations, N° 60. So that thus weakening the tenſeneſs of the affected fibres, the irritation makes no progreſs: for, as there are no membranes more bent and firm in the body, than the *pericranium* and *dura mater*, with its proceſſes; ſo their irritation muſt propagate diſorder to the greateſt diſtances; and ſince the organs of ſeeing, and hearing, ly ſo much expoſed to their action, no wonder that from it we have

have ſuch confuſions in both theſe ſenſes; as likeways in the courſe of the blood under all their ailments; ſince both the veſſels which bring in the blood, and carry it out, are quite involved with theſe membranes. And hence all the moſt frightful appearances, and death itſelf, ſo commonly attending the diſorders of the head: whereas we find that the ſubſtance of the brain itſelf is taken out in ſpoonfuls with little or no feeling, as we might expect from its want of elaſticity and conſiſtence.

We ſee, then, by the moſt manifeſt examples, what fits the muſcles, and muſcular parts, to be wrought upon by *ſtimuli*, and how various theſe are in their nature and effects; all which attended to, eaſily account for theſe connexions and ſympathies we ſee amongſt different parts in their ſufferings; whereas the reaſoning upon this head, from the nerves, is both unintelligible and arbitrary; as there are few nerves in the body, but what you may find have ſome alliance or other with ſome other nerve. But more of this in treating of the brain; and, as to ſome other of the more diſtant ſympathies, we ſhall ſee

one conſiderable riſe of them from the mind in the next chapter.

I ſhall end this, with obſerving, that the ſtate of the muſcles which fit them for action, and their manner of acting, ſeems to have been obvious to moſt of the more attentive expoſitors of the animal œconomy. As to Mr. *Winſlow*, who, in 46th article of ſect. 3. gives the following *phænomena* accompanying the action of the muſcles: the fleſhy portion of the muſcle then appears harder and more ſwelled, and the more ſo, the more they continue in action; nay, it increaſes by merely adding to the weight or reſiſtance of the part moved; and the motion may be increaſed, diminiſhed, accelerated, retarded or ſtopped, and may be made to ceaſe in an inſtant, and be produced again as quickly; and, during the contraction, the fibres are obſerved plainly knit, and furled up zigzac-ways, as all painters draw muſcles in action. This, I think, ſhould have led him to ſee plainly what the action of the muſcles was; a more compact knitting together of the longitudinal chain of particles, in each fibre, of which the muſcles conſiſt, which ſwells it in the middle,

and

and hardens it at the fame time: but the quicknefs with which this was done confounded him, and he could find no agent in the body fufficient for it; yet we fee a fimple *ftimulus* affects all; and, as we faid, even out of the body, the applying it to any one fibre, makes the whole mufcle knit at once, and furl up; what more quick? what more efficacious? And therefore it is manifeft, the make of the mufcle is contrived fo as to be wrought upon in the eafieft and moft fimple manner. Allow then the mind to act in this fimple way as a *ftimulus*; and we find that no new difpofition in the mufcle itfelf is requifite: by its native make, it is pliant to fuch an agent, which is all the Anatomift and Phyfiologift have to obferve. And to this reafoning nothing adds more ftrength, than that we find the increafe of the weight increafes the contraction. This is a plain increafe to the *ftimulus*; for we perceive in a living animal, that the weight irritates more and more the mufcle or mufcles fupporting it, the more it is increafed. But as this will be the better apprehended, after we have confidered the part the mind acts, we fhall not

inſiſt on it longer here. But I ſhall conclude this chapter, with obſerving, that nothing illuſtrates this doctrine more, than what *Winſlow* has obſerved in the laſt pages of his treatiſe on the muſcles, and Dr. *Crawfurd* in the laſt volume of *Medical Eſſays*; where they ſhew, That a juſt regard to the muſcles employed in all the different motions of the body, is neceſſary in order to inveſtigate, not only the ſeat, but the nature of the pain under diſeaſes; muſcles often having pains very different from what is purely vaſcular, under their tonic motion, or when in a contracted ſtate. Thus, theſe who fix the *ſcapula*, if overſtretched and broke by a bruiſe, or any other cauſe, cannot allow the action of pronation or ſupination; for to do this, the bruiſed muſcles ſtrain to put themſelves in action, and fix the *ſcapula*, and thereby quicken the pain; which the ignorant Anatomiſt is apt to imagine flows ſome how from the arm, whoſe action produces it; whereupon, as *Winſlow* obſerves, ſome recourſe is made to indeterminate ideas of ſome communication between the nerves and veſſels of the fore arm, and of the ſhoulder; which would

make

make them ſuſpect obſtructions in the veſſels, or irritation or ſtrain in the nerves, *&c.* and, on this foundation, would order the application of remedies to the parts anſwering to thoſe veſſels and nerves; and after a great time employed in the cure, the diſeaſe muſt cure of itſelf, or perhaps increaſe and occaſion diſorders of a worſe nature, if not death itſelf. Thus concluded Mr. *Winſlow* againſt thoſe who went in ſearch of obſcure cauſes, when the knowledge of the co-operation of the muſcles would have been a right director to them in their practice. I had a caſe which confirms greatly what Mr. *Winſlow* obſerves: A young woman, much ſubject to the *cardialgia*, was ſeized with rheumatic pains, under which the right ſhoulder was affected; the *cardia* ſuffered ſo much at the ſame time, that ſhe could not ſwallow down the leaſt drop of any thing, without hazard of ſuffocation; and the moment it reached the *cardia*, ſhe cried out, to hold her ſhoulder-blade, which then had the moſt acute pain, and, by getting it kept firm, ſhe ſwallowed with greater eaſe. What is the connexion between the *cardia* and right ſhoulder? None at all.

But,

But, upon ſhrinking up the ſhoulders, under the pain of the *cardia*, as we do in moſt of the quicker pains, the right affected at this time ſuffered greatly, and was made ſecure againſt the pain, by being kept firm. But as the mind was an agent here, ſuch inſtances come more particularly to be conſidered in the following chapter.

CHAP. IV.

Of the part the mind acts in moving the muſcles.

HOWEVER obſcure it is in what manner the mind exerts her faculties, and wherein her being ſubſiſts, and in what ſhape ſhe occupies and is confined to any certain ſpace; yet, as long as we allow thought to be that wherein her power and ſtrength conſiſt, and whereby ſhe diſcovers herſelf, we cannot be at a loſs to judge when ſhe interpoſes in any action.

AND, if we allow contrivance to be the reſult of thought, we cannot well refuſe that all complex machinery, where the different parts

parts confpire to produce, by their conjunct operation, fome common effects, is moft certainly the product of a mind; and that the inftruments employed to finifh it, when neceffary, are all under her direction. But in what manner our mind makes the machinery, reared up by another mind, exert itfelf, according to the powers lodged in her, is what we have no comprehenfion of, even at the time we make her exert thefe powers.

It is not to be expected then, in our prefent undertaking, that we concern ourfelves with thofe queftions, which, by all the more fober writers on the animal œconomy, have been fhunned. What we propofe chiefly to confider, are the conditions which make the body anfwer the commands of the mind moft eafily; and again, the circumftances which feem moft to add to the power of the mind in commanding it.

For finding thefe out, little more is neceffary than to give fuch attention to the ftate of the mufcles, in their action and preparation for it, as to view what real change they undergo at that time.

And thus, when considering the *sphincters* in their contracted state, and examining them, by thrusting our finger into their cavity, we find, by the resistance they make, that they are not then relaxed, as *Borellus* argues, but in a state wherein they are corrugated, and have their parts knit together; which is most different from relaxation, and what is justly opposed to the stretched state, to which those of *Borellus*'s opinion would oppose the relaxation, though this never takes place except in a diseased state.

And from this it appears, how unjustly the muscles are reckoned to be inflated when protuberant upon the corrugation. This is no more than an accumulation of the parts that were carried diffusively asunder when stretched; and therefore, to prevent mistakes, should be called a reduction of them, in opposition to their former state.

We have a most evident example of this in the *uterus*, which dilates to a prodigious extent under pregnancy; and then, when free, reduceth itself to its former compactness, in which it is hard and firm. To suppose this reduction done by an inflation of its

fibres

fibres from an acceffion of fome fluid, when diminifhed fo far, when fo firm and compact, would be equally abfurd, as to fuppofe it relaxed, contrary to all our fenfes.

Nay, there are no mufcular parts, if left long in the contracted ftate, without being fometimes ftretched, but acquire fuch a firmnefs, that they allow not to be eafily ftretched again; or, if you force them to it, they fuffer the greateft pain in the operation; and thus the flexors of the limbs, left long in a contracted ftate, as they are always when folded, acquire a great rigidity, and muft be gradually lengthened out again, by proper means; which fhews how far the mufcles are from being relaxed in their contracted ftate.

And thus it is that parts daily ufed are eafily moved, and more pliable to the caufes which affect them, than parts feldom employed; and therefore it is, that every tradefman has certain mufcles he employs, with eafe, in his own bufinefs, while he finds a tirefome pain in attempting the work of another, which requires the application of other mufcles. As we faid in our firft chapter, then,

the contraction is the native courſe the muſcular parts run into, while the ſtretching or dilatation is never obtained in a ſound body, except by force; in the *ſphincters* wanting antagoniſts, by forcing ſome body, different from the muſcle itſelf, into its cavity, and, in the other muſcles, by the help of antagoniſts.

And thus, as moſt of the muſcles are deſigned for inſtruments to move the different parts of the body we employ in the affairs of life, there are about 500 of them which have antagoniſts, that is, which can be employed mutually in ſtretching their fellows; and only a few of the *ſphincter-kind* left without ſuch helps: nor, in the affairs of life, do they need them, ſince ſuch of them as have no antagoniſt, can do no ſervice, except when contracted, or, when they have ſome fluid perpetually at hand which ſerves, as an antagoniſt, to dilate them, when their dilatation is neceſſary, as in the caſe of the heart.

This view of the muſcles, makes a plain diſcovery what ſituation they muſt be in before they are employed in any action; they muſt, more or leſs, be put on the ſtretch, which,

which, in every caſe, is done as mechanically as we bend the bow, by means of the cord, before we make it exert any force.

Nevertheless the mind, the great agent which employs the muſcles, has no notion of the ſituation of the muſcles when ſhe employs them, nor has ſhe any concern about them. It is the action they perform which ſhe propoſes; and the ſmalleſt degree of an inclination for it, the leaſt act of the will, makes it effectual. Thus, when the arm is folded, and, in that caſe, we would lift up a weight, the firſt thing we do is to ſtretch out the arm, which is done by the extenſors, and thereby the flexors are ſtretched, which are to raiſe up and ſupport the weight; and this the Peaſant does as certainly and expeditiouſly as the moſt expert Anatomiſt. The mind, then, regards not the inſtruments ſhe employs; inſtruct her in the action ſhe is to do, and ſhe, by aſſenting to it, and propoſing to do it with herſelf, accompliſhes the ſame, if within the power of the muſcles to accompliſh, without any knowledge of the muſcles ſhe employs.

AND thus, if any difpofition in the ftomach, or the touch of the lips of a child, gives fuch an inclination to fuck, as to make it defire the action, it can be no more ftrange to find it fo readily and neatly exercifing that action, than to find it fometime after purfuing, with its eyes, a moving light it has a fatisfaction in looking at. In both cafes, the fimple volition gives it the command of all the mufcles neceffary to the action.

AND the fame way it is, that, in performing a multitude of the moft different actions in courfe, to do it regularly, we want only to have the courfe made familiar to our imagination, or to have fome prompter to direct us in it, and then we go through it as expeditioufly as our imagination can follow it.

THUS we reckon, that the addrefs we acquire in walking, dancing, fencing, writing, *&c.* is more the improvement of the mind than body: by our leffons in thefe arts, we fix ideas in our minds of the poftures neceffary in every part of the performance; and as we become more ready and exact in conceiving thefe, we perform them the more expeditioufly and neatly. If we fuppofe all the parts then equally pliable, as a little ufe makes

makes them, we perform the moſt complex motions, where the greateſt variety of muſcles are employed, with the ſame expedition we do the more ſimple, when the ideas of the action are equally ſimple: thus we turn about a wheel, as eaſily as we move our finger backwards and forwards; and make the fingers in both hands move towards or from the thumbs, all at once, moſt eaſily, while we find difficulty to move them one way in one hand, and the oppoſite way in the other, not from any difficulty in the muſcles, which move equally eaſy to both ſides, but from the diverſity in the thought, which requires a much greater attention. After the ſame manner, in viewing any object placed aſide, the two eyes are turned by very different muſcles; yet it is done with the greateſt expedition, becauſe we propoſe one uniform action to view one object: but if we ſhould place a like object on the other ſide, and would try to turn an eye to each at the ſame time, we would find great difficulty in it, not from any oppoſition in the muſcles employed, which move alike eaſily to both ſides, but from the attention requiſite to regard two objects,

objects, in such a situation, equally at once: and thus beggars, among whom different pieces of money are thrown, do not run so expeditiously, as they would do to one piece only, from their attention being divided. What intricate and various successions find we in the action of the muscles, and how many act at once, when led by music; which points out to each its particular part, and leads them uniformly on in the same course. The book lying open, has marks chalking out the road distinctly, and the mind, copying from it, directs the fingers, in the most various courses, along the keys of the harpsicord; the head and legs join in concert; the active eyes make the first movement, and the ears are always attentive, examining every step, for which their muscles are ever active: thus almost the whole muscles of the body play, as it were, at the same time; especially if the player adds singing to the spinet; which he has no difficulty to do, and that without any opposition from interfering muscles: all is lead by the same thread, one established tune, which is equally the director, whether marked before the player, or fixed in his memory.

We ſee, then, what a variety of muſcles, placed at the greateſt diſtances, concur in the ſame action; and that they are never refractory in any action, when the mind is diſtinct and poſitive in her commands: and thus the country-dances are carried on, by the direction of muſic, with the greateſt harmony. But, confuſe the fancy, by making it follow ſome aukward irregular courſe, without a director, and we will be at a loſs as to what we are about, and as to the muſcles we are to employ, and bungle, in the performance, like frighted ſailors in a ſtorm, flying from rope to rope to little purpoſe: thus we find whence the expedition ariſes, in moving the muſcles, and in accelerating or retarding their motion. Nor is there a muſcle in the body employed to keep the equilibrium, but what the mind is directly preſent with; for the weight of the parts they ſupport hanging upon them, when the natural balance in any inſtance happens not to be preſerved, gives the mind a ſenſation that lets her know her duty in the caſe; and thereby ſhe is directed how far to reduce the muſcles, to wit, till ſhe finds no weight. And as the parts, when poiſed, give

give the muſcles the leaſt ſtreſs to retain them in their place; hence in general the muſcles bring them as much as poſſible to this: but as there are many parts, which, in their natural ſituation in the body, are not equally poiſed by their own weight, ſuch as the head, as it is ſet on the firſt of the *vertebræ*; therefore there is an allowance made for this in the muſcles: thus, for moving the head, the *erector* muſcles are made vaſtly ſtronger than thoſe which bring the head forward, and by that means keep the head ſtraight, without great uneaſineſs: but when the mind is inattentive, as under drowſineſs, the head falls forward by its own weight; and thus ſhews to us, that when kept ſtraight, it is by the mind's preſence, and actually keeping the *erector* muſcles contracted by its *Fiat*, as it muſt do moſt of the muſcles of the ſpine and inferior limbs when we are ſtanding: ſo that then the mind actually attends and plies a great variety of muſcles, and is led to it by a greater or leſſer ſenſation of pain, which is the conductor to the mind in this caſe, and fixes her attention to the place where ſhe is to act, though in very different corners; which

ſhe

ſhe would not do ſo readily, if ſhe had been to project where to apply the inſtrúments, without a monitor, as well as to execute; both which ſhe muſt do, when ſhe would attend to two different objects at a diſtance from the body by two diſtinct organs; which would require a management to be got only by attention and practice; as ſome people write, and dictate to a writer, and converſe, at one and the ſame time; which requires practice and ſtrength of mind.

And as the mind is engaged to apply herſelf, by the uneaſy ſenſation, where-ever it obtains; ſo, according to the degree of that uneaſineſs, ſhe exerts herſelf more or leſs vigorouſly; as is obſervable in a woman in labour, whoſe expelling muſcles act with more or leſs vigour, according to her degree of pain; a *teneſmus*, or a ſuppoſitary, can procure a diſcharge, which we cannot of ourſelves produce; a touch of the ſpur or whip makes the horſe walk firmly, who is apt to ſtumble; and, in lifting a weight, we make the muſcles exert more force than they can do under a leſs ſenſation of uneaſineſs: and thus people are often reckoned to

I act

act above their ſtrength, and in fact have been found in the effort to do violence to the muſcles, by the irritated mind, and occaſioned inflammations, ſtrains, &c. Dr. *Mead*, in his accurate treatiſe on the poiſon of the mad-dog, tells us, he ſaw a caſe of a madman, who, by one effort, broke at once all the cords he was bound with, and immediately died paralytic, as if all the fibres of the body had been overſtrained, ſays the Doctor, and torn to pieces. It happens often, when riding, that, upon our horſe's ſtumbling, we exert ſuch a force by our limbs, while we cling to our horſe to ſave ourſelves, that we raiſe the moſt uneaſy cramps; ſo that, under concern and ſurprize, we exert a greater muſcular force than poſſibly we can do in cold blood. And we read, in a late tranſaction of the Royal ſociety, of one *Axford*, who, after the loſs of the uſe of his tongue for four years, immediately recovered it again, in ſtraining violently to cry in a frightful dream; which procures credit to the ſtory of *Crœſus*'s dumb ſon related by *Herodot*. And thus it appears, that the mind when cool and under paſſion acts as differently upon the muſcles,

as

as the different *ſtimulus* of water only warmed and an iron made red hot.

THE whole of our doctrine appears manifeſt in the caſe of the *uterus*, which, as we obſerved, is a muſcular part which allows of the greateſt diſtenſion, and changes its ſtate often after puberty. This bowel, when not diſtended to any degree, as it is not for ſome time after the periodical diſcharge, is as little affected by cold or paſſion as any in the body; but when the diſcharge is at hand, or not completed, in which caſe, its veſſels, and with them the body of the *uterus* itſelf, are diſtended to ſome degree; then a drop of cold water on any part of the body or any degree of ſurprize, raiſes the greateſt confuſion, and prevents or ſtops the diſcharge; which ſhews that ſurprize, or the paſſions, and a *ſtimulus*, act the ſame way upon theſe parts under diſtenſion, as we have ſaid before: this is ſtill more evident in child-bed, when the diſtenſion of that bowel is greater; for then a much leſs *ſtimulus*, a much leſs ſurprize, ſtops the *lochia*, and produces all the bad conſequences attending it.

By

By which both the analogy of the operation of a *ftimulus*, and that of the mind upon the mufcular parts, appears; and likeways that they act the eafier, the more the part is diftended on which they act, agreeably to *Borelli*'s account: and, in many cafes, there is fuch a concurrence of *ftimulus* and the mind, that it is not eafy diftinctly to determine the fhare each of them has in the action. Thus, when we find the *pupilla* of the eye contracted, upon our facing a greater light, we are apt to imagine that the *ftimulus* of light, acting immediately upon the circular fibres of the eye, produceth it; whereas, a fmall fkill in optics may fatisfy us, that where the *focus* forms, there the *ftimulus* is chiefly felt; and that this fenfation induceth the mind to contract the more ftretched parts about the eye, to exclude the offending caufe. And thus the dilated *pupilla* and eye-lids are contracted: both thefe parts were dilated and ftretched before the acceffion of the light, and therefore became obfequious to the mind.

When the *anus*, bladder, or *os uteri*, are irritated, if no other part but the *fphincters* exerted themfelves, there would never be any difcharge

discharge from such a cause; but, as the *stimulus*, immediately applied to them, causes a stronger constriction, the mind, in opposition to it, reduceth the diaphragm, as much as possible, and the muscles of the abdomen, at the same time; though, for ordinary, they act alternately, and thereby push open the *sphincters*, and set off the *stimulus* by a superior force: and if any *stimulus* acts more violently, the mind, to overcome its force, musters up all its strength, and, with violent convulsions, tries to get rid of the enemy. What strange convulsions are raised, when a crumb of bread or drop of water falls into the *glottis*? Not only the diaphragm, and other muscles assisting in making a full inspiration, act at the instigation of the mind, but immediately after it a full expiration is forced by her, as now all the muscles subservient for it are on the stretch, and thereby she studies to carry off the *stimulus* in the greater current of the air: nay, shoulders, arms, legs, and head, though of little effect in the *nisus*, join in it, and shew themselves concerned when the œconomy is in hazard of being overturned.

For

For thus it is, that, in greater cafes of danger, the mind herfelf, being confufed, acts precipitantly, and is not confined, in her operations, to what is altogether neceffary. Nay, in frights and furprizes, as when alarmed with a thunder-clap, fhe acts upon every moveable part, and thereby, inftead of helping herfelf, her feet fhake under her body, and cannot fupport it; and moft other parts are convulfed; the heart palpitates, and fhews that the mind has accefs even to its hidden retreat; for there is no moment wherein either the auricles or ventricles of the heart are not in *diaftole*, and, confequently, may feel the effects of the mind when acting confufedly in the body, under a general conftęrnation.

The heart, then, like the other parts provided with antagonifts, is greatly under the influence of the mind when diftended; and that we cannot affect it, when the mind acts coolly, can be owing to nothing but its being under the perpetual influences of other caufes, (as fhall be fhewn when we treat of the circulation) and by them dilated and contracted fo quickly, that the mind has fcarce time deliberately to interpofe; though often, in

in other caſes, ſhe does interpoſe ſo inſenſibly to herſelf, that ſhe reflects not that ſhe has done it. And thus, though every man has the compoſing of his own features, and aſſumes a certain poſture to his body; yet aſk the moſt of people, and they will refuſe they ever had any concern in it; nor does the Philoſopher know it, except by a train of obſervations, which he compares and ſets together: He thus finds out that his demure thoughtful air, ſo different from the *charlatans*, was of his own acquiſition as much as the apiſh turn of the other's face was of his. Nor is it leſs certain, that the ecſtatic devotee, the furious rake, and intriguing politician, have acquired their features, by their ways of thinking, which always have certain muſcles, in active form, attending them as their ſatellites.

The Philoſopher's eyes look moſtly inward; the devotee's look to heaven with concern; the politician's ſtare at others at the time he dwells with himſelf, and therefore has a great mixture in his look; the rake has always the pert oggle in his countenance; yet none of them have the muſcles in view which they exerciſe in their different deliberations.

But

But as the ſubject of our thoughts is either ſome metaphyſical idea we ſuppoſe exiſting within ourſelves, or ſome object placed without us, which we can view with more or leſs freedom, and muſt attend with ſome particular addreſs; hence inſenſibly we fall into the poſture moſt ſuited to that addreſs; and thereby every perſon, according to his more ordinary purſuits, acquires a certain mien; though the bulk of people acquire more of this from imitation, from the mien and carriage of thoſe with whom they converſe moſt: and thus, one language, accent, and different phraſes, the manner of walking, looking, *&c.* become peculiar to towns, counties, and nations; the mind, according to the ideas of any action raiſed in her, more or leſs performs the ſame; and as the ſame action, in different perſons is performed by the ſame inſtruments, hence it is that certain muſcles become conſpicuous, and give the ſame caſt to the perſon's looks and mien, guided by the ſame examples.

In a word according to the ideas the mind entertains, however ſhe has got them, ſhe works upon the body. How are we raiſed with

with proſperity! how depreſſed with adverſity! it is ordinarily ſaid in theſe caſes that the ſpirits are raiſed or depreſſed: but in fact it is the mind herſelf; for the thoughts are the firſt things concerned; and, in conſequence only to their diſpoſition, the body is diſpoſed. What is the conſequence of the Mathematician's falling upon ſome agreeable medium to ſolve ſome knotty problem; the mother's meeting with an only ſon, after many years abſence, amidſt a courſe of dangers; or the covetous man meeting the ore in the mine, where he had buried his eſtate, though they had been long ſilent; yet now the *Eureca* meets the ears of all their acquaintance, and no liquor could have given them ſuch a chearful look, ſuch elocution, expreſſion, and flow of words? they graſp the hands of all they meet, and fly while they walk; every aching and pain leaves them, and their blunted appetite now has an edge; their parched jaws flow with moiſture; nor is there any ſtop in their breathing. But how contrary is the caſe of thoſe who have been greatly diſappointed! a flat pulſe, forced breathing, dull countenance, interrupted ſleep,

achings and feebleneſs in every joint; and thus the mind moſt certainly produces in the body effects moſt ſimilar to thoſe produced by a good diet, exerciſe, and the generous glaſs; which for ordinary keep our machinery in trim: and the countenance of a Phyſician often cures diſeaſes by itſelf, and may ſometimes kill.

It may be juſtly demanded of the Phyſiologiſt, whence this power of the ſoul over the body?

If once we could determine what was the immediate cauſe of the diſorder, removed by the ſoul, we ſhould, I reckon, have ſome proſpect of determining the part the mind acted in removing it; and nothing can ſo much help us to find this out, as a thorough acquaintance with the animal œconomy: for ſince the queſtion is, what raiſed, or more or leſs curbed, ſome action of the body, or made it difficult or painful to perform it, we muſt certainly know the inſtruments by which that action is performed, before we can judge what makes them pliable and eaſy, and what in any ſhape diſorders them.

Upon

Upon this account it is, that the regular Phyfician, in tracing what makes us tired or unwieldy in our motions, always examines into the ftate of the mufcles; and, in difturbances in the circulation and refpiration, he examines into the ftate of the inftruments employed in carrying them on: for thefe actions cannot be changed, but in as far as the inftruments change in their manner of acting.

But it may be faid, that as every inftrument of motion is animated by the fpirits, hence it is that the mind has nothing to regard but them; as they flow, the inftruments act.

This might be allowed, if the mind was concerned in nothing but the raifing or retarding the motions of the inftruments; but if, while fhe does this, fhe fhall at the fame time be found to raife a great variety of fenfations, as many as are raifed by all the different foods and drugs we ufe, it is not eafy to conceive how the fpirits, unchanged in themfelves, but only more or lefs accelerated in their motion by the mind, fhould accomplifh this.

And this power of the mind in raifing fenfations, and with them the confequences that attend them, is paft all contradiction: The fight of an orange gives an agreeable tafte, and caufes a difcharge of the *faliva*: the fight of a vomit or purge will produce the effects which ordinarily attend them when taken inwardly: bread pills, taken with a confidence that they were mercurial, have procured a falivation. Mr. *Boyle* tells us of a friend of his who fet off his urine upon feeing a top run, and of a *Gafcoign* Knight who did the fame when the bag-pipes played. By all which, I perfuade myfelf, it muft be admitted, that there is fcarce an action performed by any kind of *ftimulus*, but what can be copied and performed by the fancy, or a ftrong idea of what effects a *ftimulus* has produced. I would therefore afk, whether or not we can fuppofe, that the fancy operates upon one part, and the *ftimulus* upon another?

In our account of the action of *ftimuli*, I reckon, I made it evident, that the difference of their operation was from the different way in which they agitated the fibrous

parts

parts to which they were applied; and in this ſentiment, I think, I follow the opinion of the more judicious of our profeſſion.

Is it not then a natural queſtion to demand, whether or not the fancy, which is led by theſe *ſtimuli*, or the notion of their operation, acts upon the ſame fibres; and, by affecting them after the ſame manner, produces the ſame effect?

Or, ſhall we ſuppoſe, that the fancy neglects the organ the other inſtruments work upon, and applies itſelf to certain ſubtile fluids in the brain, and ſends them to affect the organ?

If this laſt caſe ſhall be maintained, then we muſt allow, that this fluid which we reckon the ſame in every nerve, as it is touched variouſly, touches variouſly the fibres where they land, cauſing a ſalivation in one caſe, vomiting in another, purging in a third, *&c.* and upon the ſame ſenſe, produce ſweetneſs, ſourneſs, bitterneſs, *&c.* Indeed one and the ſame bow, upon the ſame viol, gives us great variety of ſounds; but then it is when applied to different cords or different parts of them, or with a difference in the application; which

which changes cannot take place in the fpirits confined to their fixed canals, and muft land with the fame mildnefs we allow them in the brain; which in no cafe allows them to act as *ftimuli*.

Whereas the fancy acting differently upon the fame fibres, is agreeable to the powers we have always allowed it; to affect them in a way conformed to the ideas imprinted upon it, which muft change as the *ftimuli* change whence the ideas arofe.

The queftion is diftinctly this, whether or not we fhall allow that the fancy applies herfelf to the fame organ, in making it act after the fame manner the *ftimuli* had done? for example, if, by taking a bit of orange into our mouth, we bring into it a flow of agreeable moifture, whether or no fhall we allow, when only, upon feeing an orange again, the fame flow happens, that it did fo from the fame organs being immediately affected by the fancy in a fimilar way with the touch of the orange; and thence conclude, the fancy, by its energy, which is fo ftrong and various, accomplifhes on the fibres whatever the *ftimuli* can do? That it is fo, may be made obvious

to

to the eye itſelf; for if you hold a bit of an orange before a child, who uſes to be fond of it, and make him gape for it, and then examine his tongue, you will find the organ of taſte greatly affected, all its *papillæ* erect above the ſurface of the tongue, and his mouth filled with moiſture; ſo that you may reckon he has taſted it before it comes his length. And thus we are forced to acknowledge, that the fancy has not only a very certain acceſs to every fibre in the body, but, by having the idea of any particular effect produced by the *ſtimuli*, does, in fact, make them repeat the ſame, by its inſtigation.

The *ſtimuli* are thus the touch-ſtone to diſcover what are the proper organs for ſuch and ſuch effects, for taſte, nauſeouſneſs, vomiting, &c. and when other cauſes, beſides theſe *ſtimuli*, produce the ſame effects, to reckon they are applied to any other organ, is to give up the ſtricteſt analogy by which we can, and ought to judge, and to leave ourſelves without all rule.

In all theſe caſes it is the ſtrong idea of the effect that leads the fancy, which never concerns herſelf with the inſtruments ſhe em-

ploys

ploys to accompliſh it; though, in every caſe, we have plain evidences that there are proper inſtruments for theſe effects, and that ſhe produces none of them without their mediation. May we not then admit it as a certain and eſtabliſhed law, that there is no action that the machinery of the body can accompliſh, but what the fancy can make them produce directly, if once ſhe has got a diſtinct idea of the action?

THAT it is ſo in the actions we perform by the more diſtinct muſcles, we reckon we have put beyond all queſtion; and that we have a like command over every fibre, capable to be agitated by any *ſtimulus*, we have given ſome of the cleareſt inſtances; and by them are led to judge of one ſtep the great Author of nature has taken to move us to the particular actions he deſigned us to perform: he has taken care that for that purpoſe, on occaſions, the idea of the action ſhould be ſtrongly impreſſed upon our imaginations. The touch of the lips of an infant, new-born, raiſes in it an idea of ſucking, or the inclination to graſp, ſqueeze and draw with them; and this is attended with the

the exerciſe of all the muſcles neceſſary to perform it: certain views, certain feelings, and certain ſmells, excite to venery in different animals, according to the ideas nature has made to attend theſe ſenſations; which ſhould make us leſs ſurpriſed at what otherways would ſeem altogether incredible, that the ſight of a perſon deeply coloured in a jaundice, ſhould preſently produce that diſeaſe; of which I knew two examples in women with child. So that the idea of the colour produced the diſeaſe in perſons who knew not the ſeat of the liver, where the change happened, on which the diſeaſe did immediately depend: that the ſight of ſuch a colour, diſguiſing the whole body, ſhould have influenced the biliary ducts, ſo as to force back the bile into the blood, is nothing more ſurpriſing to me, than to find an infant, tho' blind, repeating the words pronounced in its hearing; what is the connexion between the ſound and the organs employed to form it? In no caſe do we want the idea how, or by what inſtruments the action is to be done, but purely of the effect that they are to produce, and, by thinking on this, the in-

ſtruments exert themſelves, and produce it.

And thus the fancy often produces great effects againſt the perſon's will; as when it turns him ſick upon the ſmell of a tar-rope, which brought to his mind the ſickneſs he had long been expoſed to a-ſhip-board, where that ſmell predomined; or vomits on ſight of white wine, or purges on ſmelling rhubarb: the idea of the action makes it take place, whether the perſon wills it or not: and hence the foundation of *Sydenham*'s obſervation ſeems eaſily accounted for, That the hypochondriacs are men of genius, if we make the ſentence convertible, and aſſert, that men of genius are hypochondriacs, to wit, men of ready fancy, who paſs moſt in company for men of genius; for ſuch having once felt pain, can eaſily create it anew to themſelves again, and that without deſign: and, by neglecting pain, or uſing ſome diverſion to carry our thoughts from it, or by reading our good fortune in the Doctor's face, and thereby ſatisfying ourſelves that we labour under no material trouble; by getting free of the thoughts of it, we actually get quite of the trouble itſelf.

And the Physician sometimes finds it a successful stratagem, to free his patient of a pain that has fixed itself, to raise a greater at some distance from it; being fully satisfied of the justness of *Hippocrates*'s observation, That the greater pain extinguishes the lesser *(aph.* 48. 2.*)* by carrying the mind from it.

Thus, to divert a toothach, Dr. *Heister*, in his *Practice* of *Medicine*, proposes, as an approven remedy, to apply a blister on the joint between the *humerus* and cubit on the same side; and I have known it often applied to the knob of the opposite shoulder with success: in which cases no connexion of nerves, no derivation of humours, can be suspected as the cause; for when the blisters begin to ruffle these joints, and before much humour has got vent, the inflammation leaves the jaws, greatly encouraged by our attention. And thus in the patient we mentioned before, when her throat was greatly contracted, the scratching the arm diverted the mind and contraction at the same time.

After the same manner we find the sensories, agreeably touched, greatly divert uneasiness and pain; the weary and faint are

recruited,

recruited, while the flavorous wine is yet in their mouth, and ſometimes even by its ſmell; the imagination carries it to all the limbs long before its ſtream has reached them, and its known influence is thus repeated: the view of agreeable fields gives vigour to the countenance of the ſick, and ſpreads their wholeſome look to the moſt hidden receſſes of the ſprings of life; whereas the ſight of our neighbours fears, brings a load on every limb, directs our fancy to their ſources in ourſelves, and makes the heart to throb. In a word, the charming our ſenſories has ſuch an influence upon the mind, and its compoſure, and delights; ſuch an influence in compoſing the diſorders of the body, that in this view, the ſenſories, in conjunction with the mind, may be look'd upon as the tempering key, which tunes aright every part of the machine. I own it is difficult to conceive, how the rays of light, reflected from a pleaſant field, and made to ſtrike upon the organ of viſion, ſhould ſo much animate the whole ſyſtem; and that other rays, ſtriking the ſame organ, ſhould have a very different effect; but that it is by the mediation of the mind,

I perſuade myſelf, every Philoſopher is now ſatisfied: and therefore we muſt allow, that the mind, according to the ideas raiſed in her, however acquired, acts upon every member, and every fibre; and thus does either diſorder or tune them; while it is quite ſurpriſing to us, how the various, and ſcarce ſenſible, touch of any of theſe organs, ſhould ſo variouſly affect the mind, and the mind ſo variouſly again affect the fibrous parts.

We find that it is eaſy to calculate what the regular muſcles perform when they are made to exert themſelves: their poſition and attachments determine this; and while they exert themſelves, we likewiſe have found that all their parts run cloſer together. This we ſee a *ſtimulus* does directly; and when the mind produces the ſame effect, it is but juſt to reckon ſhe does it by the ſame means; tho' we cannot conceive how the mind touches ſo as to irritate like a *ſtimulus*. This is all the myſtery! and as no Philoſopher has pretended to explain the action of the mind upon matter, in any caſe, we muſt be allowed in this reſpect to ſtop here with them: to explain this was no part of our undertaking.

Our

Our undertaking was to fhew the facts, what the mind did in the body; and to follow as far as we could the difpofition of the parts that made the mind obtain the command of them.

Nor could we find a better rule to judge of her power, than firft to find what different *ftimuli* did; for as this fhewed the things to be practicable, fo we found the mind likewife could perform them; and that it was reafonable to judge that it was by means of the fame inftruments.

Every different word requires the ufe of different mufcles to apply differently the organs of fpeech: this is done in every nation, however different their language, by children, who do not fo much as know that they have peculiar organs deftined for that ufe: and even children born blind fpeak by the ear, by which they have diftinct ideas of the different words pronounced in their hearing; fo that the idea how a word is founded enables them to found it over again; whence this judgment of the fancy, or the mind, in applying herfelf to the organs fo much to purpofe, in thefe cafes, is not eafily to be inveftigated;

ſtigated: we attempt the thing confidently, and it is done; much as the paralytic man did in obedience to our Saviour, after fruitleſs atempts for ſome time before. Nor ſeems the thing to be void of myſtery, however common, that the mind ſhould thus ſo readily combine the muſcles neceſſary to produce any given ſound, whoſe variety can ſcarce be defined by numbers. And I cannot give any further account of it, than what I have hitherto given, that the muſcles are ſo ſubjected to the mind, that when ſhe willeth any thing in their power, they directly perform it, if in health. A diſtinct hearing, makes a diſtinct and eaſy rehearſing: and the myſtery in going through all the varieties the different words of different languages require, is no greater, than when we propoſe to take hold of any thing with our hand; the mind immediately engages all thoſe muſcles in the action neceſſary for it. And on this power of the ſoul, ſeems to depend all the wonders wrought by our fancy on the body.

When, for example, the ſight of *ipecacuana* makes one ſick and to vomit; what is more in this, than that the fancy, by the ſight

of

of *ipecacuana*, is brought to remember the ſickneſs the drug had cauſed; and the idea of this, is the copy according to which ſhe affects the fibres of the ſtomach. And thus the power we give the mind, is that of being a very exact copier: give her the copy, and ſhe will follow it; not indeed always upon the firſt inſtance, but generally when they come to be repeated: and thus it is ſeldom, that one doſe of a vomit leaves the impreſſion ſo ſtrong, that the mind can eaſily copy it; but repeat the vomit, and the moſt dull fancies will be trained to imitate: by this means the leſſon is better imprinted upon them, and thereby they can be more diſtinct in copying.

And according as people have more of fancy upon any other account, they become the more ready imitators; as moſt women have in pregnancy, and therefore they go very ſurpriſing lengths in this work; and as their child has very pliable and delicate organs, the effects of their improved fancy come to be very ſtrong and manifeſt upon the child.

Jacob ſeems to have been well verſed in this piece of natural hiſtory, when he ſet the

the peeled rods before the ſtrong of the flock, and by that means made their offspring ring-ſtreaked, ſpeckled and ſpotted, which were to fall to his ſhare; while the feeble were left to *Laban* his father-in-law. Nothing is more myſterious, nothing more certain, than this operation of the fancy!

And though theſe leſs frequent effects ſeem extraordinary, yet, when conſidered duly, they have nothing more myſterious than the more ordinary; as when an attentive child repeats after a maſter words he pronounces before it: how amazing is it to find the attentive mind compounding the ſound the word requires, by the conjunct help of a variety of muſcles, of lips, tongue, noſe, and throat; each of them acts a part, tho' they ſeem as inſtantaneous in their action, as that of the finger in diſcharging the fowling piece, when the ſtrickler, cock, flint and powder, act their ſeveral parts: the very hearing of the word leads the mind diſtinctly to each muſcle neceſſary, though ſhe has no idea of their ſituation, or ſo much as knows that ſuch inſtruments are employed. Is this leſs ſtupendous, than that the ſame fancy ſhould irritate

the fibres of the ſtomach as the *ipecacuana* did, or the tongue and jaws, as the orange does? in both it is the imitation of effects, which are placed diſtinctly before it, upon the pliable fibres.

THE mind, then, can act upon any fibre of the body, or any part made up of them, which any other agent can affect, if ſhe is brought to have a diſtinct idea of the effect.

AND ſince, in many circumſtances, the fancy is more lively, or more apt to be touched, of conſequence in theſe ſhe gains more command over the body; and the ſtronger the object ſtrikes, the fancy muſt act with the greater certainty.

AND, laſtly, the more vigorous and pliable the fibres are to which the fancy applies herſelf, her force muſt be more conſpicuous.

AND thus we learn the power the ſoul has over the body, and what muſt add to and ſubtract from it. And, in illuſtrating theſe points, we perſuade ourſelves, we have ſet things in ſuch a light, as to judge, on good grounds, that as the ſoul produceth no effects in the body, without the mediation of ſome inſtruments fitted for that purpoſe, ſo ſhe directly

rectly applies herself to these instruments: for since, according to her different ideas, she produceth different effects, where can we suppose she applies herself, but to these instruments which different *stimuli* affect when they produce the like effects?

And, in as much as the mother, by her fancy, affects the child as variously as herself, though there is no communication by nerves between them, we must allow that the mind wants not the assistance of nerves for that purpose; which shall be further illustrated, when we treat of the brain and sensories.

To conclude all I have to say on muscular motion, I must give my opinion (agreeably to that of the learned Dr. *Pemberton*'s, in the last paragraph of his introduction to Mr. *Cowper*'s treatise on the muscles) that we cannot make a much greater progress in so recluse a subject, while we are wholly strangers to the principle that causes the parts of matter to adhere together; and how it comes to pass that this principle should operate with so much force, while the parts of the solid body are yet kept from the most intimate contact they are capable of. How can we know, but there

there is ſome power in animals that can operate upon this principle, which keeps the parts of their fibres together, and can ſtrengthen the effects thereof upon proper occaſions ; ſo that the particles of theſe fibres ſhall be made to approach each other with great force. Thus that learned Gentleman ſuppoſed, after ſhewing the inconſiſtencies of the veſicular ſyſtem : and I pretend to have done nothing more, than to have ſhewn in fact, that the muſcular parts do yield and dilate ; and that in this caſe it is, as the moſt proper occaſion, that the mind makes them return to their contact, or makes them again approach each other with great force, and that without the intervention of any other matter than what they had in their ſtretched ſtate ; which we ſee every *ſtimulus* can likewiſe do.

In no caſe do we ſee more plainly the proceſs and inſtruments for it, than what is done in the action of the muſcles. In every caſe we find how they are ſtretched, and muſt be ſenſible what advantage this gives them ; and that their being ſubject to the will, depends upon their having antagoniſts to ſtretch them.

After

After this ſtretching, the mind finds no difficulty to move any part, in any ſhape, of which ſhe can be made to have an idea, if the muſcles are capable to perform it.

HERE the mind acts upon a machine in the moſt ſimple manner, fitted, by its make, to anſwer her purpoſes; ſhe doing no more than the moſt ordinary *ſtimulus* does. And this ſuch muſt admit, who will not allow that the mind acts directly on the muſcles, but by mediation of ſome ſubtile fluid; for in that caſe the muſcle acts altogether mechanically, by the aſſiſtance only of a material agent employed by the mind; and therefore the whole action here is mechanical.

THE whole of our doctrine we further illuſtrate, in accounting for the circulation and reſpiration, in which the muſcles have the chief agency.

ESSAY

ESSAY II.

Of the Circulation of the Blood.

IN the foregoing diſſertation, we endeavoured to ſhew that it is the natural make of muſcular fibres, in a live animal, whence their power ariſes, of being ſtretched; and of their recoiling and recovering their former ſituation of themſelves, when left at liberty; that is, while they are in the ſound body, they are greatly elaſtic.—And farther, we endeavoured to ſhew, that, in fact, they are always ſtretched or bended before they come to be employed in moving any part; which gives us to underſtand, that the ſtretching of a muſcle is the great preparation for its exerting itſelf:—and we have ſhewn further, that all the muſcles commonly reckoned voluntary, are either kept ſtretched in the body, or can eaſily be made ſo by an antagoniſt that is ſtretched; in which caſe, either ſome irritating *ſtimulus*, or the mind, by

by its native power to irritate or contract them, brings them into action;—that is, we ſhewed how the machinery is fitted to be played upon; which is all that Philoſophers pretended to ſearch after. And the beauty of our hypotheſis lies in this, that the moſt eſtabliſhed motions and courſes in the body may be eaſily explained by it, without any further *data* than the ſtructure of the parts, as Anatomy has delineated them: and this we ſhall further illuſtrate, in accounting for the circulation of the blood, and the reſpiration, the two great and immediate inſtruments of life; which, in our way of explaining them, will be found to be nothing elſe than examples of our doctrine in the former ſection; and may therefore be reckoned a continuation of it, or additional arguments to ſhew the juſtneſs and certainty of what we there advanced. We ſhould begin with the anatomy of the parts concerned: but, as we have nothing new to advance upon this head, we ſhall ſuppoſe them known, that we may embarraſs this treatiſe as little as poſſible; that is, we ſuppoſe our readers have before them what the modern Anatomiſts, *Winſlow* in particular, have

delivered on the ſubject; by whom it is made manifeſt, that the heart is a very ſtrong muſcle, forming two cavities, more or leſs capacious, as the muſcular fibres are more or leſs contracted;—they communicate not one with another immediately, but the anterior cavity, commonly called the right, communicates, on one hand, with the artery, whoſe branches ſpread over every hair-breadth of the lungs, to which it ſends the blood it diſcharges; and, on the other, with the *venæ cavæ*, into which the whole ſyſtem of the veins, not employed in any ſecretion, ſpread over every part of the body, except the lungs, come at length to empty themſelves, and thereby ſupply this cavity; and the other, called the poſterior or left, communicates by one paſſage with the veins of the lungs, from whence only it has its ſupplies, and by another with the *aorta*, the root or trunk of all the arteries of the body, except theſe of the heart and lungs. It is through theſe cavities of the heart the blood has its conſtant rotation, and is determined in it by the poſition of the valves affixed to them, and to the arteries ariſing from them. For the anterior cavity has a broad tricuſpid

tricuſpid valve ſo placed over the paſſage from the veins, as to give a free paſſage to the venous blood in it, but does not allow it to return that way; and the poſterior, after the ſame manner, has a two-pointed valve placed over the paſſage from the pulmonary veins to the ſame purpoſe; whereas the pulmonary artery and *aorta*, immediately at their riſe from theſe cavities, have each three ſemilunary valves, making a compleat circle round their cavities, ſo placed as to allow a free paſſage from the heart, but no return to it by theſe arteries. *Cæſalpinus* had a very diſtinct notion of this courſe (as we find by the account of it, in his *Cataptron Medicum, lib.* 6. *cap.* 19.) *Oſcula*, ſays he, *ad baſin cordis quatuor poſita ſunt; venarum et arteriarum principia, ſecundum Ariſtotelem; duo ſanguinem introducentia, duo educentia, tam in dextro ventriculo, quàm in ſiniſtro; in dextro oſculum introducens eſt ad venam cavam, educens autem arteria eſt in pulmonem: in ſiniſtro venæ oſculum eſt introducens ex pulmone, educens autem eſt arteriæ aortæ principium, ſingulis oſculis membranæ quædam appoſitæ ſunt, quæ intromittentibus aperiuntur ad ingreſſum*

ſanguinis, clauduntur autem ad egreſſum; oppoſito modo in educentibus patent ad egreſſum, clauduntur ad ingreſſum, ut continuus motus fieret ex venis in cor; et ex corde in arteriis: though, through all his works, he ſeems to have but a confuſed notion of the courſe in the veins and arteries and their communication; which was left to the great *Harvey* to demonſtrate, and thereby to render compleat the whole doctrine of the motion of the blood: for though, after the courſe of the blood through the heart was eſtabliſhed, one would have thought it natural to ſuppoſe a free communication betwixt the arteries and the veins; yet the notions, which had prepoſſeſſed Anatomiſts, made neceſſary the many experiments *Harvey* adduced for it; all which I ſuppoſe now eſtabliſhed; and, therefore, ſhall repeat nothing this great author advanced for that purpoſe. But, ſuppoſing the fact, the taſk I take upon me, is to ſhew the inſtruments, and the way they are applied, by which the blood is compelled in this courſe. There is no Phyſiologiſt now, but allows that it is the contraction of the ventricles of the heart, by which the blood is forced into the arteries

arteries arifing from them. But then, the great queftion is, whence this great contraction, and what, in turns, fhould make it relax again, or rather, in the terms I chufe, ftretch? which I reckon very different from it, as may be eafily underftood, by my comments in the former Effay. To fuppofe this ftretching to happen of itfelf, is to fuppofe a turn in the contracted fibres of the heart moft different from what the fibres have in any other part of the body; where it is admitted, after the ftricteft examination, that the fibres, in a ftate of health, always affect the contracted ftate, and become the more firm in it, the feldomer they are ftretched. I formerly noticed that when fibres were contracted beyond their tone, by the force of a *ftimulus*, that, upon the *ftimulus* ceafing, the fibres returned to their natural ftate of contraction, which is a fpontaneous relaxation, or a relaxation by the proper action of the fibres; and that was properly fo, as the contraction is fpontaneous, when a mufcle over-ftretched returns to its natural contracted ftate; and therefore, when we fay the fibres affect a contracted ftate, it muft be underftood a ftate of contraction

traction to a certain degree only; for, when forced beyond this, they affect what we call comparatively a relaxed ſtate. And thus, the animal fibres, like other elaſtic bodies, can either be made to condenſe, that is, contract, or dilate, that is, ſtretch beyond their native tone.—Now, if we ſay that the heart relaxed of itſelf, after contracting, then it muſt be ſhewn that its contraction was greater than what flowed purely from the tone of its fibres: for, in this caſe only, it can ſpontaneouſly relax; and then it would follow, in conſequence of this, that we ought to ſhew a *ſtimulus*, or ſome other cauſe of the extraordinary contraction, ſo as to account for the action of the heart; which ſome imagine they have done, when they obſerve that the heart is ſupplied by the eighth pair of nerves paſſing to it between the *aorta*, and pulmonary artery. But why ſhould the nerves of this pair occaſion a more violent contraction than thoſe of any other pair? and if they do it to the heart, why not to all the parts to which they ſend off branches? amongſt which are many of the voluntary muſcles, particularly thoſe of the *larynx* and *os hyoides*: and if it be allowed, that the

the contraction is to no greater degree than what its natural tone gives it, then there can be no natural relaxation; and whence, in that caſe, the *diaſtole?*

For this, ſome have advanced, that there is an extraordinary relaxation occaſioned by the compreſſion of the great cardiac *plexus* of nerves, lying between the two large arteries, at their riſe; but the authors of this reaſon have been too fond of it, when they have neglected *Morgagnus* and *Vieuſſens* obſervations, that ſometimes that *plexus* did not take this rout at all to the heart :—*Winſlow*'s account, in his anatomy of the moſt ordinary courſe of it, is, that the chief filaments run in the cellular ſubſtance behind the *aorta*, as well as between it and the pulmonary artery, ſo that all of them would never be compreſſed; and that theſe filaments ſerve the auricles as well as the body of the heart, ſo that the auricles would be relaxed with it, which would prevent their contraction which takes place when the ventricles are in their *diaſtole.* Since, then, the eighth pair of nerves, with its aſſociates, ſerve promiſcuouſly voluntary and involuntary muſcles, membranes, glands, and bones, we can

ſucceed

fucceed nothing in our reafonings, from the fpecialities in this nerve, to account for the fpecialities in any of thefe parts; nor is there any part whofe action is lefs capable of being explained by the obfcure nerves, than that of the heart, which is purely mufcular; and how a mufcle acts, we have explained above: the only thing in debate concerning the heart is, what ftretches it, or what caufes the *diaftole*, under which the fibres are diftended beyond their natural tone, and confequently muft be under the influence of fome foreign power.

All authors feem fatisfied that the *apparatus* at the entry of the ventricles, is fome how adapted for pufhing in the blood; and, with *Hoffman*, *cordis modum fequi vaforum modum*; that the heart is contracted more or lefs ftrongly, or more or lefs frequently, *&c.* according to the ftrength and frequency of the pufh of the venous blood; that is, that its *fyftoles* were determined by it; and yet they could not be perfuaded that the venous blood was ftrong enough to dilate the ventricles; for, if this was allowed, there was nothing more wonderful in the contraction of the ventricles of the heart, than in that of any

fphincter.

ſphincter.—To illuſtrate the caſe of the heart's *diaſtole*, we ſhall ſhew the *apparatus* for puſhing the blood into it; and, then, the experiments which ſhew that the *ſyſtole* is in conſequence of this.

Anatomists and obſervators ſeem to have determined very indiſtinctly the parts which act and move conjunctly in puſhing the blood into the heart. By the modern debates, concerning the ſize of the ventricles and auricles, one would believe that it is the general or prevailing opinion, that the auricles only ſupplied the ventricles; whereas, if we attend to the ſpaces bounded by valves, we ſhall find that not the auricles only, but, with them, a great tract of the neighbouring veſſels, at once ſupply the ventricles: for, upon the poſterior ſide, *Ruyſch* has ſhewn us, in his 13th epiſtle, that the pulmonary veins unite before the ventricle, and make up the greateſt part of the auricle, or at leaſt one cavity with it; and, at the ſame time, we know that there are no valves between this cavity and the branches of veins opening into it; nay, nor between the pulmonary arteries and their veins, the firſt valves that we meet being the ſemilunary, at the riſe of the artery from

from the anterior ventricle: what, then, in the time of the *systole* of this ventricle, can hinder the blood from flowing, in one continued stream, through the pulmonary arteries and veins to the left auricle, and thus from filling them all at once? For, as the blood does not move in separate parts, or in a body like a ball discharged from an engine, but like the waves of the sea, which follow close one immediately upon another, it is probable, that the blood has reached the pulmonary veins, or rather the auricle, before the ventricle has done contracting, or exerted its full force, in discharging itself into the arteries: nor is there any thing to hinder this progress, since all the passages are open, unless it be some little blood left in the veins after their last supply to the posterior ventricle, which must necessarily be pushed forward. So that, I say, the blood, upon the contraction of the anterior ventricle must move all at once, in arteries and veins through the lungs towards the left auricle; and, consequently must all at once distend and prepare all these several vessels to push their contents conjunctly, or with one united force, into the posterior ventricle; which they

do

do upon the anterior ventricles ceaſing to act, or its recovering its contracted ſtate: and as this repreſents to us both the ventricles at the ſame time, preciſely in the ſame ſtate, ſo, from hence, we ſee, that their action muſt be ſynchronous; and the ſame muſt be underſtood of the action of the auricles, which here appear both of them diſtended, whilſt the ventricles are contracted. But that nothing of this could poſſibly happen, unleſs the veſſels of the lungs did all of them act conjunctly, is very apparent; for if the anterior ventricle puſhed the blood only into the pulmonary arteries, and theſe arteries into the veins and their appendix the auricle, which can never act ſeparately; in that caſe, whilſt this ventricle was acting, the poſterior auricle would, at the ſame time, be likewiſe acting; which is impoſſible. I conclude, therefore, that the pulmonary arteries, veins, and poſterior auricle, do all at once receive their ſupplies and diſcharge them again: and, had this been attended to, how plain would the courſe of the blood have been? and how many idle controverſies about the dimenſions of thoſe veſſels prevented?

FROM the ſame way of judging, we muſt allow, that it is not the anterior auricle, by itſelf, which immediately ſupplies its ventricle, but with it the whole tract of veins unſeparated from it by valves; and thus we muſt allow, the whole ſuperior *cava* to be as one ciſtern with the auricle; we meeting no valves till we come to the axillaries and jugulars, at whoſe riſe *Fabricius ab Aquapendente* diſcovered them, as *Euſtachius* did in the inferior *cava*, immediately upon its paſſing the diaphragm: ſo that here we have a pretty large ciſtern to ſupply this ventricle, and of a much larger capacity than the ventricle itſelf. And that all of it acts conjunctly in filling the ventricle, is agreeable to an obſervation of *Wallæus*, in his letter to *Thomas Bartholine de motu chyli*; where, ſpeaking of the motion of the *cava*, he ſays, *Motus autem ille venæ cavæ propè cor evidentiſſimus eſt*; *ut plurimum eum quoque in vivis canibus obſervavimus toto illo tractu ab hepate, & à jugulo ad cor uſque*, that is, thro' the ſpace we have mentioned. Now, the queſtion is, if theſe venous parts, with the auricle, are capable to dilate the ventricle by their contraction? for if they are, then we

ſee

ſee the inſtruments which naturally prepare the ventricle for action; as the antagoniſts of the muſcles not hollow do extend, and prepare their fellows; and if we examine facts, they ſeem greatly to prove it. Thus every thing which accelerates the venous blood, or its return to this laſt receptacle, immediately before the ventricle, haſtens and enlarges the *ſyſtole* of the heart; or, as *Hoffman* obſerved, the motion of the heart is determined by the veſſels ſupplying it with blood: by this failing, the perſon becomes faintiſh, with a languid pulſe, if not a compleat intermiſſion of it, and ſwooning.—The pulſe too is more or leſs full or frequent, according as the reſpiration makes more or leſs impreſſion upon the abdomen.—In a perſon ſtanding, it beats about a ſeventh oftener than when ſitting; at which time the abdominal muſcles lying looſe, do not ſo much aſſiſt the diaphragm, in preſſing the blood returning by the abdominal veins; which likewiſe is the cauſe that women after child-bed are quite faintiſh, if not girded; and ſuch as are tap'd for a dropſy; and that the *Scythians* bore hunger longer and eaſier when girded than other-

otherways; as *Aulus Gellius* tells us, from *Erasistratus*, in *chap.* 16. *lib.* 3. of his *noctes Atticæ*. But the girding must not be over strong, as I found on trial, otherwise the circulation will be quite stopt; whereas the small pressures increase it; as we find, from Mr. *Hales*, in the experiments where he made the largest evacuations in dogs; for when, by them, the pulse was quite sunk, a small pressure on their belly at once raised the pulse, as muscular motion does, by which the venous blood is hastened to the heart. What can we imagine more decisive in any question, since the heart shews more or less force, and acts quicker or slower instantly, according to the force of the venous blood upon it? for whatever virtue we reckon in the animal spirits, if they change their way of acting, in consequence of the venous blood moving quicker or slower, the motion of the heart must be changed prior to that of the animal spirits. The great *Harvey* observed the course at the heart most distinctly, in opening live animals; as we find in the 4th chapter of the circulation, where, from his observations, he concludes, *Sic prius desinit cor pulsare, quam auriculæ,*

riculæ, ut auriculæ ſupervivere dicantur, primus omnium deſinit pulſare ſiniſter ventriculus, deinde ejus auricula; demum dexter ventriculus ultimò reliquis omnibus ceſſantibus & mortuis pulſat uſque dextra auricula, uti ultimò in dextra auricula vita remanere videatur. Et dum ſenſim emoritur cor, videre licet poſt duas aut tres pulſationes auricularum aliquando quaſi expergefactum cor reſpondere, & unum pulſum lentè & ægrè peragere & moliri. Sed & præcipuè notandum, quod poſtquam ceſſavit cor pulſare, adhuc auricula pulſante, digito ſuper ventriculum cordis poſito, ſingulæ pulſationes percipiuntur in ventriculis; eodem planè modo, quæ ventriculorum pulſationes in arteriis ſentiri antea diximus à ſanguinis impulſu nimirum diſtenſione facta, &c. If the action depended on the nerves, what ſhould make the auricles move longer than the ventricles? but if on the blood, we muſt allow, that as the poſterior parts of the heart are ſupplied from the anterior, that theſe muſt firſt fail; and even the anterior ventricle before its auricle, ſince it is ſupplied by it. So that what *Harvey* obſerved was as reaſonable, on our ſuppoſition, as that the mill-wheel ſhould decreaſe in motion,

tion, as does the ſtream which makes it move; and that at length it ſhould ſtand ſtill while the ſtream was moving, though too weakly for it. And thus he obſerves, that the motion firſt began in the umbilical veſſels, and thence to the auricles; and at length to the ventricles; *Capite ultimo Exercit.* And, in the ſame chapter, he obſerves that the auricle is always proportioned in ſtrength to the ventricle in different animals, *ad impellendum et implendum*; than which nothing can make it more evident, that the ventricles owe their diſtenſion, or *diaſtole*, to the force of the venous blood returning to them; and thus we find how the ventricles of the heart are brought to that ſtretchedneſs or degree of tenſion, we reckon a preparation for muſcles to make them exert themſelves; every obſervation confirms it; and the moſt obvious *phænomena* we meet with every day, argue for it: ſo that there can be no objection againſt this doctrine, but the plainneſs of it.

In our arguing, we have obviated the objection, that this courſe we have eſtabliſhed is a *circulus in cauſis*; for we have ſhewn, that, without the aſſiſtance of reſpiration, the ve-

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nous blood did not return with ſufficient force to fill and diſtend the auricle, to prepare it to act upon the ventricle: ſo that here is a new force perpetually ſuperadded to the returning blood: This we find in fact to be a *ſine qua non* in the circulation: by this, and the action of the arteries and veins themſelves, while in a ſtate of dilatation, the anterior auricle, and thoracic parts of the *cavæ*, are greatly bended; for they are dilating all the time the right ventricle is contracting; and thus they are in their greateſt ſtrength, when the ſtrength of the ventricle is ſpent; and then they make their puſh according to which the ventricle is more or leſs dilated; which of neceſſity makes its puſh in its turn: and as the whole thoracic part of the *cavæ* joins with the auricle, the impreſſion they make on the ventricle muſt be great: every part of this larger bounds contracting and giving an impulſe to the fluid; ſo that the *momentum* with which it acts on the ventricle, muſt be made up of what reſults from this compound preſſure, and ſo make up the loſs of what each part wants in ſtrength of the parts of the ventricle; and, as it contains more than the

the ventricle can receive in a ſtate of health, it never returns to its greateſt degree of contraction, having ſtill more or leſs blood in reſerve, and contracts only ſo far as it is able to make the ventricle yield or recede from its natural tone; ſo that each part of the ciſtern acts from a greater ſtretch than the ventricle, and muſt of conſequence in this reſpect do it with greater vigour; and thus we ſee, that neceſſarily, when the auricle acts faintly, the ventricle muſt do ſo likewiſe, and *vice verſa*, according to what we find to be fact: but the chief thing to be regarded, in the courſe of the action of different parts of the heart, is, that when the auricles have loſt moſt of their force, by their contraction, the arteries have done ſo likewiſe; and thereby the reſiſtance of the ſemilunary valves to the action of the ventricle is diminiſhed; and conſequently the *diaſtole* of the ventricles can ſubſiſt no longer: and thus the *ſyſtole* takes place with ſuch a puſh from every quarter, as the propped wall falls downward, by forcing away the prop; for it is manifeſt, that except theſe valves make reſiſtance, the ventricles could not be dilated at all by the blood; ſince they

make

make up a part of the enclofer where it is contained; and therefore we may judge of the force neceffary to fupport the ventricles, by the refiftance they give; which is confiderable, when the arteries are full and prefs their blood againft thefe valves: but when the arteries fubfide, which they do againft the time the ventricles are full, the valves can make no refiftance at all; and thus the fluices are opened, and the ventricles begin their *fyftole*, fooner or later, according as the blood is received from the arteries. And this fhews, that as the quicker return of the venous blood haftens the motion of the heart, fo any ftop to the difcharge of the arteries, muft retard it; and whether or not the flefhy pillars, agitated by the ftream, adds a *ftimulus* to make the ventricles brifker in their motion, I leave every one to determine, who has confidered how certainly the touch of a pin does this.

Our doctrine, then, of mufcular motion leads us to an eafy explication of what is acted at the heart, and lets us fee that the auricle is the moderator and bender of the ventricle for motion: and as we have fhewn this in the anterior auricle and ventricle, fo it holds in the

poſterior; for when the anterior auricle has ſo far reduced itſelf in contracting, that it can affect the ventricle no longer, as it muſt do in its courſe of contracting, by which its action becomes weaker and weaker, then the ventricle, urged weakly by the auricle, and but little reſiſted by the valves, exerts itſelf, and cauſes a general dilatation of the arteries and veins of the lungs, with the poſterior auricle, which had immediately emptied themſelves into the poſterior ventricle; ſo that the moment they are emptied, or rather have their blood diminiſhed only, they are again diſtended with new ſupplies, and prepared to urge the ventricle before them, which at the ſame time has immediately diſcharged itſelf into the *aorta*, and arrived at its weakly ſtate, when the ſource whence it is filled is in the greateſt vigour; juſt as when one wave ſpends itſelf, another is following it with new vigour, and keeps up a perpetual flux; or, as the great *Harvey* juſtly ſays, in his 5th chapter, *Nec alia ratione id fit, quàm cùm in machinis una rota aliam movente, omnes ſimul moveri videantur*. Beſides that, as the lungs are under the continual preſſure of the air, both in

inſpiration

inſpiration and exſpiration, this preſſure muſt add greatly to the force of the blood in dilating the poſterior ventricle; as we ſhall fully illuſtrate in the following treatiſe. So that it is manifeſt, that the reſpiration, both as it acts immediately upon the lungs, and mediately on the lower belly, is a great cauſe of the motion of the blood and of the *diaſtole* of the heart; which is the chief thing to be inveſtigated, in order to account for the circulation. And it muſt be obſerved, that as I have argued, that through the lungs the motion of the blood in arteries, veins and auricles, is uninterrupted, both when the arteries are filling from the anterior ventricle, and when diſcharging themſelves again; ſo the ſame takes place in the *aorta* and veins communicating with it; for nothing can hinder the veins from receiving ſupplies from their arteries, even at the time theſe are a filling from the heart; and the ſame ſupplies are neceſſarily continued, when the arteries are in their *ſyſtole:* ſo that there is a conſtant ſtream into the veins; as we find the ſtream to be equal in them in venæſection; though the arteries, on their contraction, are greatly exhauſted,

exhaufted, as is the thoracic ciftern of venous blood after its contraction: and thus the bounds between this and the arteries, fupplying the veins, muft be reckoned greatly loaded when the arteries are in *fyftole*; for then the thoracic ciftern is likewife in *fyftole*, and therefore there muft be an accumulation in the veffels between the two; though at other times there is ftill a courfe into it. And from this view of things we reckon, that the whole of the circulation in the larger veffels is fully fhewn through all its changes, and the reafons of it; though in the *vena portarum* it muft have a longer circuit, and probably in fome other veins from their make.

But however plain I have made the action of the heart, and however evident it feems to be that the blood forced in upon it is the caufe of its *diaftole*; yet, when we take a fuller view of things, fomething more admirable muft appear to be in its motions, than we have brought into our account. The hearts of frogs, pigeons, and many other of the leffer animals, in a manner dance and leap when cut from their bodies warm. My Lord *Bacon*, in his *Hift. vitæ et mortis*, tells

us, that he ſaw a criminal's heart, when torn from his body, jump up and down more than a foot high for ſome minutes; as we find moſt of hearts repeat their contractions, ſeparated from their bodies, when prick'd in any one place: but does this argue any thing againſt their contracting with more or leſs force according to the diſtenſion or ſtretch made of their fibres by the venous blood? This we ſee as clearly as we do thoſe other experiments, and cannot therefore but allow it equal credit: nor can I ſee that any thing more can be argued, from the motion of hearts ſeparated from the body, than that they are moſt nicely ſet for it; ſo that the ſmalleſt *tremor* ſets the whole a going, like *Memnon*'s harp, or *Van Swieten*'s patient, with the ſun-beams. It is obvious that vegetable and animal fibres, of the ſofter make, immediately upon being ſeparated from the courſe of their nouriſhment, loſe much of their compactneſs of texture: their leſſer elementary parts, by loſing their cement, loſe ſo much of their coheſion one with another; and thus, of themſelves, they obtain a latitude to contract or move: and in this ſtate it is, that a *ſtimulus* makes

makes them contract, and affect their former degree of coheſion; tho' they cannot keep it, for want of a proper cement provided by nouriſhment. And moſt of the nicer and more obſcure powers want ſome incitement to rouſe them; as we find the electric does not appear till rouſed by friction: and why ſhould it appear more ſtrange, that the attraction among the leſſer parts of the fibres ſhould likewiſe require ſome incitement? This the air does to parts not formerly expoſed to it, for ſome time, after the death of the animal; when that fails, the touch of a pin; after that, warm water; and when this fails, the touch of a hot iron. So that when the weaker *ſtimulus* fails, the ſtronger and more penetrating can do it: than which nothing can argue more ſtrongly, that all conſiſts in the mechanical operation of the *ſtimulus* upon a machine well ſet for it. What the operation of a hot iron muſt be upon ſuch a corded elaſtic piece of work as a muſcle, is not difficult to imagine: one fibre running through it, to which the reſt are ſome how or other linked, when corrugated, which is the native effect of heat on ſuch fibres, muſt agitate the whole;

whole; and, from the counteractions among ſo many fibres as are there combined, repeated vibrations muſt happen before the firſt ſhock ceaſes: warm water acts the ſame way; and a pin may be allowed the like operation, though it acts upon leſſer bounds. In the inſtance formerly mentioned, the touch of a pin could make a ſtrong bell ſound, by making all its parts vibrate; and why not agitate a whole muſcle, one of the niceſt corded machines we know, and which can be played upon by the rays of light, as we ſaid before? How ſhould we reckon it ſo ſtrange, then, that a heart ſhould bounce and play, knitting and relaxing again, while vigorous with its native powers, and expoſed to the influence of ſuch *ſtimuli*? A man ſings over an empty glaſs, and makes it tone to his tune; and ſhall the fire appear enchanting, when a heart bounces from it, and thereby only ſhews its corrugating force? Warm water again immediately checks the motions of a fiſh's heart, and cold ſets it a moving; as *Hoffman* often obſerved, *Syſtem. vol.* 2. *p.* 33. This ſhews how they are ſet for different ſhocks: and thus Mr. *Hales* reckons the difference

ference in different *menſtrua*, is owing to the difference of the ſhock they give different bodies. But, be this as it will, it does not affect our obſervations, that muſcles muſt be on the ſtretch before they act; and that in proportion as they are ſtretched, if the coheſion of the parts be not diſſolved, they act the ſtronger; on which the whole doctrine of the circulation depends. And, as *P. Borellus*, in the laſt of his firſt century of obſervations, has obſerved, that not only the *mimoſa*, but ſeveral flowers contract all their parts, by touching one very ſlightly, this mobility, in well-adjuſted machines, ſhould not appear ſo odd; eſpecially, as he further obſerves, that, by exerciſing them a little this way, they loſe their delicacy, and ſeem not ſo pliable to the touch; not unlike the hearts, which ſtand it for a few trials; though there are others which can be kept in play very long. All depends upon the original ſtructure and vigour of the parts: the ſame way the *dura mater* gives over its action after repeated punctures, as *Baglivi* obſerves; ſo that the vegetable and animal parts, of a delicate and eaſily changed ſtructure, have that ſoon reſolved, and put out

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of tune for action, merely by exercising them: but, by reft, and the recruits they have from nourifhment, while in a live ftate, this is again reftored. Thus likewife we find, that upon the deftruction of the nerves, every part in the body becomes paralytic, as well as the mufcles. So that thefe furprifing motions which continue, for fome time, in parts feparated from the body, ferve rather to confirm than contradict our doctrine; as they are very ftrong againft thofe fuppofitions, which make an immediate flow of fpirits neceffary to bring the mufcles to action. An eel's heart beating an hour in an exhaufted receiver, as Mr. *Boyle* obferves, fhews an immediate flux not to be fo neceffary; and, even after a fecond hour, fome degree of heat fet it a going; which fhews, that fome fifhes are touched with heat, as well as cold; and is a plain proof, how the fibres of different creatures are differently difpofed for motion, and to propagate it differently, in the fame perfons, according to their ftate of health. Upon the whole, one cannot but reft fatisfied, that contraction is the native difpofition of fibres in a live and healthy animal, and rela-

xation in a dying and dead animal; and that a *ſtimulus* to any one part, makes the relaxed parts through the whole muſcle regain their contraction for a moment, as the conſtant flow of the bile keeps up the periſtaltic motion in the guts; and vomits and purges produce convulſions in them. And thus it is but natural, that the *ſphincters* and heart ſhould, in languiſhing animals, be found relaxed and open, though their *diaſtole* is not their natural ſtate, when they are in vigorous health. And thus the reaſon likewiſe appears, why particular fibres are ſeen contracting in the ſhambles, ſome time after the animal has been hung up; and the hearts of ſome animals cut into ſeveral morſels, do nevertheleſs ſhew a *ſyſtole* and *diaſtole*. Now the fibrous parts are ſeparating in courſe; but, retaining ſtill ſome of the uniting force natural to them while in life, the *ſtimulus* of the air can as certainly affect them, while endued with any degree of it, as it does the violin tun'd uniſon with another, by which the air is modulated.

P. S.

P. S. Along with this treatiſe, I muſt recommend the reading of one upon the ſame ſubject, by *Joſ. Weitbrecht*, in the 6th and 7th volumes of the *Petropolitan* Commentaries, where there is a moſt diſtinct account of the progreſs of the circulation in different receptacles and veſſels; and ſeems only deficient, in not having obſerved the uſe of the valves bounding the *cavæ* within the *thorax*, which make that portion of them, with the auricle, a diſtinct cavity, as much ſeparated from the abdominal *cava* and its branches, as the *aorta* is from the left ventricle of the heart, and ſuffers a diſtenſion and contraction like the arteries, according to *Walleus*'s obſervation, as we obſerved above. And, in a paper we laid before the Philoſophical ſociety at *Edinburgh*, in the year 1739, after we had inveſtigated, in a human ſubject, *Euſtachius*'s valve, according to *Winſlow*'s method, in the *Pariſian* Memoirs *anno* 1717, an attention to this valve ſhews, that the thoracic portion of the *cavæ* and *aorta*, have their action ſynchronous, but not the intermediate veins; whereas all the arteries and veins of the lungs, with the left auricle, are filled together, and

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then difcharge themfelves at once, in reftoring themfelves after a confiderable diftenfion, and by the affiftance of refpiration, as Mr. *Weitbrecht* allows; though he feems to have had no notion that the *finus venofus* before the right ventricle had the fame advantages, as we have fhewn above; and therefore feems to attribute their diftenfion to a vacuity in them, upon relaxing fomewhat after contraction: the whole of which goes upon fuppofitions for which there is no foundation, as we have fhewn above.

ESSAY III.

Of Respiration.

THE cavity of the breaſt is bounded by the ribs, joined behind by the *vertebræ*, and before with the *ſternum*, and filled neatly up, in their interſtices, with a double ſeries of muſcles, lined with membranes; and thus form a very cloſe barrel, though not cylindrical, being much more contracted above than below, where it is cloſed up very neatly by the diaphragm, which is a broad ſtrong muſcle, ſtretched croſs the trunk of the body obliquely, from the *ſternum* downwards, and meets the ſpine at a very acute angle; and though it lets paſs the gullet and many of the larger veſſels, yet all is made cloſe by the *pleura* attached to them on one ſide, and the *peritonæum* on the other. The two firſt ribs ly more horizontally, between the *ſternum* and ſpine, than the reſt; and though they let paſs the wind-pipe, and gullet,

gullet, with many veffels; yet, by mufcles, ligaments, and the *pleura*, the cavity of the breaft is quite clofed up here; fo that the whole cavity, examined within, is found fmooth and entirely lined with the *pleura*, made firm by a concurrence of bones, ligaments, and mufcles; and, confequently, the whole of the inclofing walls muft be quite clofe and firm.

The parts contained within it are, the heart, and the lungs, appended to the wind-pipe, together with the nerves, and blood-veffels which pafs through it, and a gland placed at the uppermoft and fore part of the *mediaftinum*; all of which are far from filling up the cavity in its enlarged ftate, when the lungs are not blown up.

But, before we confider the action of thefe parts, it will be neceffary to confider the fabric of the lungs, and the courfe of the blood-veffels through them.

The wind-pipe divides into two large branches about the fourth *vertebra* of the back; one to ferve each portion of the breaft, as it is divided longitudinally by the *mediaftinum*: thefe are immediately fubdivided into fmaller

branches,

branches, until they are brought to the greatest ſubtility, and, at length, become membranous, and are expanded into very ſmall and thin veſicles; all of which are ſo combined, as to make up cluſters quite contiguous; and out of them there are three lobes formed in the right ſide; and two in the left, poſſeſſed by the heart, and made leſs in itſelf, by the *mediaſtinum*, inclining ſomewhat more this way, in its deſcent: ſo that the cartilaginous wind-pipe, with its cartilaginous branches, and the veſſels appended to them, make up one veſicular maſs, whereof all the parts communicate with the wind-pipe, by their diſtinct conduits, and are invelopped by the *pleura*, which externally connects their convex ſurfaces.

The pulmonary artery entering the lungs near the firſt diviſion of the wind-pipe, ſends branches all along with its branches; and, at length, ſpreads its extremities over the veſicles, forming a regular net-work by their inoſculations; the veins, riſing from them here, keep by the ſame branches of the wind-pipe, till they form their four large heads joining the left auricle; and, except by theſe vaſcular attachments, the whole lungs hang quite

quite free, by the wind-pipe, in the cavity of the breaſt, lying, when unblown, cloſe upon the heart, but, when inflated, ſpreading to all the corners of that cavity; though they become not contiguous to the ſides of the breaſt, the incloſing wall; ſince air paſſes the lungs, and muſt therefore ly between them and the *pleura*; as Dr. *Hales* has evidently ſhewn, in 112th and 113th experiments of his vegetable ſtatics; and may be found by any one that will try to blow up the lungs, which he will find impracticable to keep diſtended, however faſt he ties the wind-pipe, after blowing them full, except he repeats the diſtenſion till the lungs become quite rigid and ſtiff, and ſo ſupport themſelves by their own firmneſs; which is a manifeſt proof of their being pervious, though not greatly ſo, they ſubſiding very ſlowly: and Dr. *Hales*, in his experiments, has obſerved, that it is only by a few paſſages they tranſmit air.

But, to underſtand the action of reſpiration, we are firſt to conſider the ſtate of the lungs, and cavity of the breaſt, in a child not born: in him the ribs are greatly depreſſed, and the diaphragm is thruſt up to the third or fourth

rib,

rib, as I have found by examination. In this caſe, then, the diaphragm muſt be extended greatly beyond the length it would have if lying ſtraight between the different parts to which its fibres are inſert, as we have deſcribed them; and the ribs in this poſture, lying ſpread to as great an extent as their articulations allow, the muſcles between them muſt likewiſe be greatly ſtretched beyond their tone; in which ſtate they never remain without force, as we ſhewed in treating of the contractile fibres, and with them every other muſcle muſt be ſtretched, aſſiſting to raiſe the ribs: and the lungs thus confined are found ſo compact, that they will ſink in water; which they never do after their having been once blown up.

Such, then, is the ſituation of things in the cavity of the breaſt. And as for the external force that overcomes the natural tone of theſe muſcles, and that detains them contrary to this their natural tendency in that ſtate of violence; this, without doubt, in the caſe of children yet in the womb, can be no other but the weight of the atmoſphere preſſing upon the integuments of the mother's belly; and

thereby communicating its ſuperior force to the *uterus*, and ſo to the breaſt of the child: for as the wind-pipe and *bronchia*, not yet inflated, can afford no balance to the external air, whereby the muſcles that raiſe the breaſt might be relieved from the preſſure they are under; thoſe muſcles, while the ribs accommodate themſelves to the ſmall contents of the breaſt, cannot but come to be ſtretched, and continue in this ſtate of violence, unleſs they were ſo rigid and ſtrong as not to yield to the whole ſtrength of the atmoſphere; which can at no rate be pretended.

The next thing we have to conſider, is, what happens to thoſe muſcles at the birth. Upon this event, no ſooner comes the child out of its cloſe confinement, ſo as to be expoſed to the outward air, but, this elaſtic fluid immediately pervading every open paſſage, the noſtrils, the mouth, the gullet, and, particularly, ruſhing into the wind-pipe, and cartilaginous *bronchia*, a power now enters the breaſt equal to the whole weight or force of the atmoſphere; which cannot, therefore, but relieve the intercoſtals, the diaphragm, &c. from that outward preſſure they are under:

der: for, as it is the natural disposition of every muscle to contract itself, and not to quit its contracted state, without great resistance, it is here to be considered, that, of the whole force of the atmosphere pressing upon the muscles employed in raising up the breast, it is only a certain portion of that force that keeps those muscles stretched, whilst the rest is spent in answering the resistance that arises from their contraction: so that the air introduced into the breast, being equal to the whole force of the atmosphere, cannot but prove greatly superior to that part of it which stretches those muscles; and thereby, setting them at liberty, it puts it in their power to exert their native force, to contract themselves, and so to elevate the breast, wherein the outward and inward air come to balance one another. Here, then, we see, that from the outward air rushing into the wind-pipe, and cartilaginous *bronchia*, the breast is heaved up; and, of necessity, while this is a-doing, (which is done in a moment) the subtile fluid is still penetrating farther, and reaching the vesicles; it blows up and expands the

lungs,

lungs, as it fills up every other cavity to which it can have access. But, besides this mechanism that so far contributes to the raising of the breast, the mind likewise may be conceived herein to lend her assistance, as she may thereto be incited, by a new sensation at the breast, occasioned by the run of fresh air into it, and by the new current of blood forcing its way into the lungs, whose difficulties ever after awaken greatly the attention of the mind. Thus much for the first inspiration, and how the breast comes thereby necessarily to be raised.

Now the breast thus raised, its capacity, in all its dimensions, is greatly increased; and therein the lungs, now inflated, having full room to dilate themselves, the blood (which heretofore, without touching the lungs, had passed from the *vena cava* to the left auricle and *aorta*, partly by the *foramen ovale*, and partly by a vessel lying between the roots of the pulmonary artery and *aorta)* finds a free passage through them; and comes at length to be confined to that course we described when treating of the circulation. And considering that the blood, now spread among the

the vesicles of the lungs, must be diffused over a vast surface, no less, by Dr. *Keil*'s calculation, than five times the whole surface of the body; and that at the same time it is impregnated with a degree of heat, superior to that of the sun in the dog-days, as we shew when treating of the blood; one cannot but allow, that the evaporation of its volatile sulphureous fumes, with which it abounds, must be very great through the whole extent of the breast. As therefore the air in the lungs, and every where through the breast, now overcharged with sulphureous fumes, cannot but thereby have its elasticity considerably spoil'd and broken; so this, of course, greatly diminishing that inward force or balance, by means of which the intercostals, and other muscles, were enabled to contract themselves, and so to elevate the chest, the outward pressure of the atmosphere, now superior in power, must again prevail; and, by depressing or stretching those muscles, very much lessening the cavity of the breast, the inward effete feeble air contained in the lungs, *&c.* is forced to give way, and to rush out; and herein we see the first expiration.

BUT

But again, now that the lungs are emptied of air, and if any remain in the vesicles or *bronchia*, it has lost its spring; from the nature of fluids, it is impossible, but the vigorous external air, having nothing to oppose it, must rush in again along its former course, and heave up the breasts, and inflate the lungs; till, by losing again its elasticity amidst the fumes that arise from the sulphureous parts of the blood, it loses again the balance; and, by the subsiding of the breast and lungs under the pressure of the atmosphere, is again forced out, or made to expire, and so makes way for another inspiration. And thus the machinery is carried on, till the animal comes to breathe out its last; so that, by an inevitable necessity, inspiration and expiration succeed to one another, at longer or shorter intervals, according to the force of the rising fumes, the strength of the air, and the vigour of the muscles, *&c.*

Dr. *Hales*, we find, experiment 108. *Veget. Stat.* was not able to breathe 240 cubical inches of air above a minute; for then he was not able to blow a bladder, into which he breathed,

breathed, more than half full; and confequently the lungs would keep equally flaccid, there being accefs to no frefh air to play upon the lungs; both that in the bladder and lungs being thus weakened: but though he had forced a breathing for a minute, yet, in lefs than half a minute, he found he did breathe with difficulty. And, in fact, we find, that, in the 20th part of a minute, the fumes have fo far deftroyed the air, as to leave room for a new infpiration; people in health infpiring about 20 times in a minute; and therefore, after that, if the air, once infpired, is not changed, or a freedom left for new air to fucceed, the refpiration muft always become more and more uneafy, and at length uncapable to balance the external air fo far, as to allow the mufcles, for enlarging the *thorax*, to exert themfelves.

And thus we find that it is the air that plays the whole machinery of refpiration; though, by the doctrine of animal motion by the fpirits thefe fhould have enlarged the breaft before the air could have entered its cavity: but what fhould make any new courfe in them for that purpofe, upon the birth, is not to

be

be imagined. What we have advanced, is built upon certain facts, and makes the action of the mufcles depend on the accefs of the air to the breaft; and ever after, upon a fupply of frefh and vigorous element, not to be had on the tops of mountains, or ftagnating caves, or places where fulphureous fumes prevail, whether arifing from the bowels of the earth, the bodies of men, *&c.*

Dr. *Langrifh*, by his experiments upon brutes, feems to have added much to the ftrength of thefe arguments; for, by forcing in fulphureous fumes to the different cavities of the body, and by keeping the whole body involved with them, except the lungs, the animal fuffered little; but when forced thro' the wind-pipe, killed it immediately: fo that the fulphur had no bad effect, but where it prevented the action of refpiration; though the author imagined it was by killing fome unfelt *æther*. But fince the unactive air in the lungs is ftill attended with this effect, and that in an exhaufted receiver the fame misfortune fhews itfelf, there is no need of fuch a fuppofition.

By

By the whole argument it appears, then, that the muscles of the breast are, by the force of the atmosphere, as much opposed in their tone, and put on the stretch, when the air is destroyed in the chest, as the *sphincters* are in their tone, by the bodies driven in upon them occasionally. And thus we see how such as have the organs of respiration weak, or have a difficulty of breathing upon any other account, feel so much the changes of the air. It is upon the air that the exspiration depends: it is the principal antagonist to these muscles which dilate the chest; if it languishes, the exspiration must be faint, and consequently the inspiration must return the sooner; that is, there will be a quick and faint respiration. And if we will suppose a faulty blood, not much abounding in volatile sulphureous parts, we must allow, on our hypothesis, that, in this case, as the internal air would be but slowly killed, so there would be a difficult inspiration, and a great oppression at the breast, from a rarefaction of air not killed; and the external atmosphere would be too weak an antagonist, and fail in depressing the breast

and ſtretching the muſcles. And how far the ſwelled veins, and ſtomach, and a general ſenſe of ſtraitneſs over the whole body, (which aſthmatic perſons ſo ordinarily complain of) ſhew the cauſe, I leave every one to judge: to me they greatly argue the want of that volatility in the blood, or attenuated ſulphur; and by this the air is not only felt too ſtrong in the breaſt, but in the ſtomach, and every vein; whence all the aſthmatic's uneaſineſs; for which an infuſion of *ſal volatil. corn. cerv.* and *ſuccin.* with ſulphur, was a great remedy of *Willis*'s, though he had not adverted to this theory.

The whole of this doctrine is ſo manifeſt from Dr. *Hales*'s experiments, that one would be apt to ſuſpect that it was the chief thing he had in view to eſtabliſh from them: but though he never makes any concluſion to that purpoſe, yet he is very poſitive, from his 111th experiment, that there is no vivifying ſpirit carried along with the air, cauſing that ſudden recruit of life, ſpirit, and ſtrength, we find inſtantly ariſe in languiſhing caſes, from the admiſſion of freſh air; and that all this happy ſenſation is from the fuller dilatation of the lungs, and a briſker circulation

following

following upon it: but, lest the experiments he made had not been convincing to such as had long dwelt upon the treasures the air conveyed with it, he seems, in the 114th, to have contrived an *apparatus*, to shew, that nothing was necessary for all these surprising effects of a free respiration, but the blowing up and agitating the lungs; for when the air was so effete, as not to do this of itself, by pushing it by means of a bladder appended to a dog's wind-pipe, he made this air, under whose influences the dog quite languished, cherish and revive him again, by its mere mechanical action. And thus opens a different view to us from what we had, of these cases where the air kills directly, from losing its elasticity; and shews a cause very different from what obtains in the cases where poisonous exhalations introduced to the blood kill more or less slowly, without regard to the respiration.

After taking away the cherishing virtue of the air, it must be natural to demand, why all this *apparatus* to introduce it into the body? why such a delicate cartilaginous membranous *sac* to receive it, such walls to secure this? and why should the whole mass of blood pass in

review

review before it? This, indeed, at first view, would look as if the blood received here some perfecting stroke: and we may persuade ourselves it was not for nought. And so many having engaged to shew at great length the chief design of respiration, discover how sensible Physiologists have been of the importance of this *apparatus*. Some have thought a mixture of the air with the blood was of absolute necessity. But why a particular provision for this, which is certainly done in the common course of the chyle, where there is nothing to hinder it? and therefore air must associate and go along with every drop of it, as it does with every liquid it meets; for all abound with air, and thus mix more safely with the blood: for Dr. *Langrish*'s experiments shew, that air cannot safely be admitted directly to it, (*Vid.* his last experiment upon sulphur). Nor does the mixture of the new admitted chyle with the old stock of blood, and the attenuating its particles, combining too much in the veins, seem a sufficient ground for this *apparatus*, as some would have it; a work the force of the heart and arteries are so well fitted for. What shall we

then

then assign as a sufficient task for it? To dilate the ventricles of the heart, by adding to the *momentum* of the blood forced in upon them; as we hinted, in accounting for the action of the heart, when treating of the circulation: and thus to prepare them for a vigorous contraction.

By innumerable observations, we find, if the force of the respiration is not felt upon the returning blood, that the circulation stops at once; as was manifest from a few of these we adduced in our treatise upon that subject: by which it would appear, that the respiration was the true antagonist to the *systole* of the heart. We shewed this in the case of the right ventricle; and if it has such a force mediately by the abdomen, it must certainly still more directly have it upon the left ventricle, for which the great *apparatus* of the lungs is so observably formed. These hang loose in the cavity of the breast, and have either effete air squeezed from them, or fresh dilating them; in both which cases, the numerous capillary arteries must be pressed by these different actions; and the sum of all must squeeze the blood directly upon the left ventricle,

tricle, as we took notice in the treatife of the circulation.

Now, fome have made this force extravagantly great, and others again would have it nothing at all, and adduce their calculations to fhew it. But, thefe calculations being accommodated to certain hypothefes, the accuracy of the hypothefis is more to be regarded, than that of the calculation. The facts adduced for *data*, are what fhould be firft examined; and thefe, perhaps, rightly viewed, may determine the cafe, without any calculation. Thus, in our former effay, we noticed, that if by any means the force by which the diaphragm recovered itfelf in infpiration, was diverted from the *cava* paffing through the abdomen, that the action of the heart was fufpended, and would give over altogether. Now, the force of the diaphragm is proportional to that by which the air rufhes into the breaft; for it is bended by the preffure of the atmofphere on the abdomen, and contracts in proportion as that is carried off; and this again is in proportion to the force of the air entering the *thorax*, which has the balancing the external air. But though this fhews us, that the air muft enter with a confiderable

force,

force, yet there are more direct obfervations to fhew it.

Dr. *Hoadley*, in his treatife on refpiration, *p.* 15. obferves, with others who have made perforations into the cavity of the breaft, that the lungs act with a great deal of violence upon the orifice; and again, that when a trocar was forced in between the *pleura* and lungs, they fcarce could get it to ftay, becaufe of the violence with which the air in that part of the cavity urged it; which fhews how much the air was preffed betwixt the breaft and lungs; and that it was the air which preffed, he proved, by obferving, that when the trocar was taken from the *cannula*, and an exit given to the air, the *cannula* lay eafy. It is true, the dog's agony added greatly to the force of the mufcles employed in refpiration. But yet thefe experiments fhew, what muft be the effect of the eafieft refpiration, that it muft more or lefs comprefs all parts within the breaft, efpecially the lungs themfelves, which ly between the preffures of the air in their cavity, and what they have tranfmitted to the fpace between them and the *pleura*; for the force of the exterior air cannot exceed

exceed that of the internal: and therefore, ſince this ſhewed itſelf ſo much on the trocar, the internal, or what acted in the cavity of the lungs, could not be leſs; though in expiration its force appears ſmall at the *fauces*, where a great deal of the force is loſt by the air ſpreading itſelf into noſe, mouth, and gullet. A perſon into whoſe wind-pipe we had put the *cannula* of a ſmall trocar, breathed out a conſiderable *ſibilus* through it, till a moſt threatning *angina* went off, and, upon holding a candle to the orifice, after he began to breathe pretty freely by the *glottis*, he blew out the candle at once, and ſhewed us that the air enters and paſſes again with a conſiderable force, though not obſervable at mouth or noſe. And, in this caſe, the preſſure of the lungs muſt be very great: for, in the *Heſſian* bellows, and ſuch machines, we find a vaſt force raiſed by the preſſure of a very ſmall pillar of a fluid communicating with the fluid in the bellows; and if, inſtead of ſuch a pillar, we would make a ſmall bladder communicate horizontally with the bellows, we find that the preſſure of two fingers on the bladder, would ſuſtain 100 *lbs* at leaſt upon the

bellows,

bellows, such is the effect of the pressure in these cases. And thus we see, by the plainest instances, what the effect must be of pressing the blood in the pulmonary artery and its branches, and the pulmonary veins and their branches, betwixt the air on the different sides of the lungs. All this pressure, as we have shewed in the treatise of the circulation, must land directly upon the posterior or left ventricle of the heart, and force its *diastole*. And thus the use of the lungs appears in a most open view, and that their importance is no less than what we allow the circulation to be; which we see depends upon it directly, and must be strong or weak as the respiration is; according as the most thoughtless spectators find and acknowledge: and it seems very strange that every one should acknowledge, that the violent strainings in respiration accelerate the circulation, and directly shorten and overcome the *systole* of the heart; and yet will allow nothing to the more ordinary respiration.

And, by this account of the use for which respiration is employed in the animal œconomy, we easily see, why an animal who has once

breathed, and who ſhares not of the preſſure of the mother's breathing, does inſtantly ſuffer in a place where it cannot breathe: with the breathing the circulation ſtops of neceſſity.

So that the problem which *Harvey* delayed to ſolve, and many ſince attempted to no purpoſe, appears now plain, when facts are fully attended to, without any comment. The reſpiration then preſſes every veſſel in the lungs and in the cavity of the breaſt, except it be the heart included in a cavity by itſelf; and therefore the reſpiration muſt be allowed the great antagoniſt to the heart, and with it the great inſtrument of the circulation of the blood.

THE judicious Botaniſt and curious obſerver of nature, Dr. *Houſton* (who had his degree in medicine from us, and ſpent much of his time in his younger days in this place) exhibited to the eye, moſt of the *phænomena* which help us to judge of the force and nature of inſpiration and expiration; as we find in his paper N° 441. of the tranſactions of the Royal ſociety; where he obſerves, in a dog whoſe ſkin and intercoſtal muſcles he had ſeparated

parated ſo as to leave the *pleura* entire, that, in time of inſpiration, or when the freſh air was forced into the cavity of the breaſt, it preſſed likewiſe upon the *pleura*, now bared, and made it concave: ſo that here the force of the air was diſtinctly ſeen on the *pleura*, not ſupported by elaſtic air within; whereas, if the air had not been changed within, it would have always ſo balanced the external air, that it ſhould have made no change in the *pleura*. But in expiration, he could ſcarcely call it convex: and no wonder, when now the ribs, by falling down, were greatly more ſeparated, and kept the *pleura* more tenſe; for otherwiſe it would have appeared rather more concave, as the diaphragm is in that caſe: and therefore the only time the *pleura* can be obſerved concave, is when inſpiration is near its height; that is, when the breaſt is pretty much raiſed, and the ribs furled together: for then the *pleura* muſt be looſe, and, as inſpiration is not completed, the external air muſt preſs on it ſtill, as it does through the *glottis* upon the lungs: but in the turn from inſpiration to expiration, the looſe *pleura* may be ſomewhat convex; for then,

then, upon the air within being at once destroyed by the fumes from the lungs, spread to their greatest extent, the vigorous atmosphere without, in conjunction with the muscles assisting in exspiration, now in the greatest vigour, being greatly distended, must act with a brisk *nisus*, and force up the diaphragm, and down the ribs: and as thereby the inactive air is squeezed on every hand, the *pleura*, while loose, that is, while the ribs are not greatly depressed, must rather appear convex; and the whole lungs, which appeared through the transparent *pleura*, must disappear, and the redder diaphragm come in its place; as was conspicuous in the above experiment; though in this case, upon the first contraction of the breast, if we slit through the *pleura*, some parts of the lungs would force out at the orifice; they being pressed every other where by the internal air; as in Dr. *Hales*'s experiment, they were greatly pressed by squeezing the bladder, though the air in it was effete; but in inspiration again, they are so far extended to the other parts of the breast, that they are drawn back from the orifice. Thus it was that Dr. *Houston* imagined

imagined the lungs were extended while the breast was contracted, and *vice versa*; tho' it is quite otherwise. And thus I reckon the turns in respiration are accounted for, and their true causes made obvious; as likewise its primary use. I shall only further observe, that it is probable, upon the first access of the air to the breast, that, before it is enervated, it rarifies by the heat, and thereby at its entrance gives a sudden shock to the lungs.

Since, therefore, the first dilatation of the breast depends wholly upon the muscles employed to that purpose, being originally dilated beyond their natural tone, we find, that the respiration can be only explained by the principles of muscular motion we established when treating of that subject. And thus we find, that the two chief actions in supporting life, depend on the muscles acting uniformly after the same manner.

There is no doubt but the lungs are subservient to many other purposes, for speech, *&c.*; and that the cooler air, fanning the lungs, and most of the *pleura*, may refresh such as are oppressed with heat; as the laying the hands or feet in cold water does. But

these

thefe advantages we at prefent pafs over, propofing to treat of the primary ufe only.

We have an experiment of Dr. *Mufgrave's* and Dr. *Hook's* to our purpofe, in Mr. *Lowthorp's* abridgment of the *Philofoph. Tranfact. vol.* 3. *p.* 65. 67. Dr. *Thurfton*, fays Dr. *Mufgrave*, afferts the chief ufe of refpiration to confift in maintaining a motion of the blood; but the arguments he produces to make out this affertion feeming to me infufficient, I pitched upon the following experiment, which I hope will be decifive of that matter. I took a middle-aged healthy dog, and, having freed the *trachea* from the adjacent parts, cut it off juft beneath the *pomum adami*, and turned the loofe end outward, and with a cork ftopt up the *trachea*; fome few violent ftruggles fucceeded, in which the *fternum* was raifed as in the deepeft infpiration; and thus he died, two minutes after every motion had quite ceafed: when his breaft was opened, I found the *arteria pulmonalis*, the right ventricle of the heart, with its auricle, and the two great trunks of the *cava*, diftended with blood to a great degree; the *vena pulmonalis*, left auricle and ventricle of the heart,

heart, in a manner empty, not containing more than one ſpoonful of blood: and hence he concludes, that reſpiration promotes the paſſage of the blood through the lungs; and that it is the principal uſe of reſpiration. And indeed this is generally the caſe, however the creature dies. What Dr. *Hook* advances, in the former page, ſtill argues ſtronger to this purpoſe, though he thought otherwiſe; he laid the breaſt open, and the heart denuded of the *pericardium*, and, by means of a double pair of bellows, kept the lungs quite diſtended, and furthered the blood through them, by the repeated blaſts; which were no ſooner intermitted, than the dog fell into agonizing fits; ſo that nothing but the motion of the heart, ſupported by thus acting on the lungs by alternate blaſts, ſuſtained the life. He indeed argues, that the blood moved in the lungs without the blaſt; becauſe then, cutting a bit of the lungs off, blood iſſued out: but this was owing only to the parts ſubſiding on the blood's having a paſſage made for it, though thereby it had not a ſufficient force to dilate the heart; and therefore not freſh air, but air driven with a ſufficient force, was neceſſary for life, as was manifeſt

manifest from Dr. *Hales*'s experiment; for when all the surface of the lungs was prick'd and surrounded within and without with air, as in Dr. *Hook*'s experiment, how could fresh air be wanting?

COLUMBUS, in his 14th book, where he has a collection of the experiments made on dogs while alive, says, *Si arteriam asperam inter annulum et annulum secueris, et arundinem immiseris; si eam ori admoveris, et buccis infles pulmones illico attolluntur, et cor ipsum amplexabuntur; et paulo post pulsus immutabitur, se ipso major factus, quo viso sat scio obstupesces.*

I shall end this Essay, by answering an objection of the learned *Frederick Hoffman* against our doctrine; though a great many observations in his works favour it greatly. In the preface to the third part of his 4th vol. he acquaints us, that he and his friends observed often, that the lungs were quite full and inflated with air in those who died of suffocations; and therefore argues, that the circulation could not be stopt in them for the want of a due dilatation; and, consequently, that the inflation of the lungs does not promote

promote the circulation. But I alledged before, that a ſpecies of the *aſthma*, and perhaps of the worſt kind, might depend on the want of a due quantity of the more volatile and ſulphureous parts in the blood: in which caſe, there could not be any expiration, for want of fumes to deſtroy the air within the breaſt, and no counter preſſure to promote the blood; ſo that the dilated ſtrong air would rather cauſe a ſuffocation than prevent it, by reſiſting the blood's acceſs to the lungs; though, I ſuſpect, in moſt caſes where the lungs are not deſtroyed by ulceration or putrefaction, they may be found generally inflated after death; as are the inteſtines, ſince the ſame cauſe muſt affect them, that is, the rarefaction of the air not deſtroyed by fumes; which are ſuppreſſed in the corps: and thus it is that the eyes look glazed with humour in a dying perſon, when the heat does not make it fly off: and by ducking animals ſeveral times into water, before they are kept down, they are much longer before they are quite ſuffocated; ſo that dogs and cats, who die in two minutes when kept in the water unprepared, by preparing them

continue 10 or 12 minutes alive, and divers a quarter of an hour, from the chilness of the medium in which they are: so that, by cooling the blood a little, and lessening the fumes, the air is not so soon rendered useless in the breast, and the creature so easily drowned: and thus, in the receiver, where one pigeon lives two hours, two put in together live only one; and the mercurial gauge rises something upon the death of the first. *(Institut. Acad. Bonon. tom.* 2. *part* 1. *p.* 340.*)*

In a word, attending to the nature of the fumes of the body, as Dr. *Hales* has shewn it, and the influence they have in respiration, and what this has on the circulation, opens new prospects to us of some of the principal agents which carry on the chief parts of the animal œconomy; and on whose greater or lesser energy the greatest revolutions must happen there: and thus the understanding of them must tend to the knowledge of diseases.

I have only a word to add further, occasioned by an objection lately made by some of my friends. They observe, when an animal dies in the receiver, the air has not become

come fo weak as it is on the tops of fome mountains where people remain without fudden death. True; but tho' in fuch heights the air is greatly weakened, yet it muft be confidered, that it has a free courfe from the breaft; and accefs to it again; which makes a reciprocal impulfe upon the lungs, though not fo ftrong as when the air is more vigorous; which is not the cafe in the recipient, or when we breathe from a bladder only, whofe fides check the fpreading wave in expiration, and intercept any return from a diftance; for as foon as the whole air in thofe fmall enclofures is warmed, it lofes all force, being in a perfect ftate of ftagnation; fo that after expiration, in this cafe, there is no air more vigorous, than what is contiguous to the lungs, to force its way to them, and to renew the preffure, and to balance that of the external air which had forced the expiration: and that it is the want of this alternate preffure, feems to be demonftrated from the fupplying it mechanically; as we obferved from Dr. *Hales*: and for the fame reafon it is, a candle won't burn after the air in the recipient is equally warmed; for then

nothing

nothing blows upon it, all is at reſt about it; as little or nothing blows on a fire expoſed to warm ſun-ſhine, or under cover with another fire: but on the tops of mountains, the weak chill air without the breaſt, muſt keep up its influence within the breaſt upon the changes there, though theſe are not ſo great as where the air is ſtronger.

ESSAY

ESSAY IV.

Of the Human Blood.

AN attentive conſideration of what the more ingenious and diligent obſervers of the animal *phænomena* have laid before us, promiſes to give light to thoſe things we ſeem to inquire after, with the greateſt curioſity, in the human blood.

IT is ſeldom that any thing red, or that can be ſuſpected to be blood, is found in an egg not hatched, which is made up of two obſervable humours, the yolk and the white: nevertheleſs, before any motion appears to our eye, or the *punctum ſaliens* has diſcovered itſelf, the blood is obſervable. *Quantum*, ſays *Harvey*, *ex accurata inſpectione diſcernere licuit, ſit ſanguis antequam punctum ſaliens efformatur. Exercit.* 51. And *Malpighius*, who obſerved the motion of the heart much earlier than *Harvey*, (that is, againſt the fortieth hour; whereas *Harvey* ſeems to have obſer-

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ved it only between the third and fourth day), could not determine with himſelf, whether the heart or blood was firſt ſeen; though he ſaw the heart long before he was ſenſible of its motion, ſince he had diſcovered its make even before the thirtieth hour; as he acquaints us in the appendix to his treatiſe of the egg.

From both their authorities, then, the blood was formed before there was any apparent motion, and was, in *Harvey*'s judgment, endued with the vital heat. Yet we are not to ſuppoſe there was no motion about the *cicatricula* before that time; ſince, before that, the appearances in the umbilical region were changing greatly, and the veſſels were obſerved ſwelling: but then, as it was not manifeſt, except by the effects, it could never be ſo ſtrong as to cauſe an attrition, which, by its force, would warm and fire the humours to the deep colour of blood. And what ſhould make us inſiſt upon ſo violent a cauſe to produce blood, when we find, by the moſt gentle motions in the fluids of plants, liquors produced of all manner of colours and taſtes? And certainly theſe early

times

times *Harvey* and *Malpighius* took to confider the rife of the humours, were the moft advantageous: then we were taken to nature's own elaboratory, to fee the proceffes fhe ufed in bringing each humour to perfection. Here we find, by their obfervation, that the fimple white of the egg, by the gentle heat of incubation, became, in the umbilical veffels, firft yellow, then of the rufty iron colour, and at length red. Neverthelefs, we muft not imagine, that, without the vafcular fyftem, this would have happened; for we find, in fact, when the egg is not cock'd, or the embryo grows not, as frequently happens, that the hatching heat turns this radical humour of the white into a fetid dark *ferum*: fo that the action of the imperceivable veffels upon this *ferum*, or rather the mixture from different veffels with the heat, is the great caufe of the change; and as veffel and veffel is brought to action, and bowel formed after bowel, fo the animal abounds in a multiplicity of fluids of moft different afpects; as many as you could have produced in a fpot of ground equal to the compafs of our body, by throwing into it as many different feeds as

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it could have ſupplied; and that in a very ſimilar manner, to wit, by the operation of different veſſels upon one and the ſame fluid: much, therefore, after the ſame manner as different plants work differently upon the crude juices of the earth, does the different veſſels of the animal work upon the ſimple juices of the egg; and thence ripen and produce every fluid found in the animal body. But as no Philoſopher has yet ſhewn the peculiarities in 'the root of the betraw, which makes it turn all the juices into the dark red, while the rhubarb makes them yellow, and the dentilion white, or, in a word, accounts for the colour of the juice of any one plant: while the different plants, among them, yield an infinite variety of colours, no more can we expect to give an account of the animal fluids as they change among their different veſſels. This is the prerogative of the Supreme Being, who made the animal, and could calculate its growth from the firſt atom he contrived as a proper root or element for it; who could limit every part to a certain degree of extenſion, conſiſtence, &c. and fit them to receive certain liquids to be thrown out of the body as uſeleſs,

uſeleſs, or to form new ones, to be employed for certain purpoſes, in helping the animal functions: ſo that, as we cannot determine every change of a veſſel, attended with a change in the fluid, or obſerve the ſmaller veſſels frequently uniting, and, by their compoſitions, forming fluids, we never can calculate the ingredients entering into the compoſition of the maſs in the larger veſſels, or theſe fluids peculiar to ſome branches from them.

Let us then be content to obſerve the product of the divine machine, as *Harvey* and *Malpighius* were; with whom we ſay, that the blood is the product of the animal elaboratory, which works firſt upon the ſimple fluids of the egg, and then upon the food the riper animal takes: but as this food is in a greater ſtate of crudity than the firſt nouriſhment was, we find a gradual mixture of animal juices provided to digeſt it, or aſſimilate it to the animal juices, before it is admitted to the maſs, while it is paſſing through a very long tract of veſſels to it; as is known to ſuch who have at all conſidered the animal œconomy: and againſt the time it comes to

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the laſt part of this tract, it is formed into one homogeneous white fluid, not unlike, in all appearances, to milk, which falling drop and drop into the blood returning to the heart, is loſt among it, and, after a few courſes with it, is found quite of a piece with it: and thus the blood, in perfect animals, is daily recruited.

And though, conſidering this acceſſion of new parts to it, and what a diſcharge there is daily of ſo much of the old ſtock by the ſecretions, we ſhould imagine, that, in ſhort intervals, there would be a total change of the blood; yet we have ſtrong arguments to ſatisfy us that this does not happen: for not only does it keep paternal infections, after the greateſt changes in the maſs, through a long tract of years, but we find that it is ſuſceptible of the ſmall-pox, till once it has got a depuration by the infection; and that, after this, no infection of that kind takes impreſſion on the blood: and therefore, we may conclude, that part of the firſt ſtock is ſtill permanent with it; and that by it is ſupported its moſt diſtinguiſhed property of heat, which is abſolutely neceſſary for all its functions.

ctions. And thus it was, that, at firſt, nothing was wanting to bring to action the *ſtamina* of the embryo, but heat; which ſucceeds equally, whether communicated from the mother, or an adventitious fire; ſince, in *Egypt*, hatching ſucceeds by the heat of an oven, as much as by the mother's heat; and I have by me a young crocodile, preſerved in ſpirits, produced aboard a ſhip from the egg, kept in ſand, expoſed to the hot ſeaſon in the *Mediterranean*: and therefore, we muſt be ſenſible, that the firſt heat, which begins the animal life, has nothing in it, but what is common to fire in general. But then, the great queſtion is, what ſupports this in the riper animal, we find always glowing with a like heat, independent of any external cauſe. All animals borrow their heat at firſt to kindle their humours; but once ſet on fire, their heat never goes out again, as long as life exiſts; which made *Harvey*, in his book *De calido innato*, name the blood, thus warmed, *Lar familiaris, calidum innatum, ſol microcoſmi, ignis platonis; non quod ignis communis inſtar, luceat, & urat, & deſtruat; ſed quod vago & perpetuo motu, ſeipſum conſervet, nutriat, & au-*

geat.

geat. It is the true vital fire, which never can go out, without carrying the life with it; and therefore by it we judge of a person's being living or dead.

In eight different persons Mr. *Amontons* examined by the thermometer, the greatest heat was 9, and the least 2 lines above 58 inches; which was a very small difference in the spirit-thermometer he used; though the pulse of the highest only beat 66 times in a minute, when the lowest beat 68. *Memoires de l'acad. à Paris* 1703. so that the beats of the pulse did not correspond to the heat. And the same author agrees with the *English* author he comments on, that the greatest height the human body could raise the thermometer to, was not out 59 inches, while at *Paris* he reckoned the solstice heat only above 58; so that, by his account, it did not exceed the human heat. And, in *Fahrenhiet*'s thermometer, Dr. *Martin*, who was most diligent in his experiments upon this head, found his own heat, and that of several others, raised it between the 97 and 98 degrees. Yet several of our domestick animals raised it between 100 and 103, and fowls between this and 107; whereas, in *Italy*, the greatest

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ſun's heat was about 89 only, though in an extraordinary ſeaſon 91; and in *Holland*, obſerved by *Muſchenbroek*, the length of 94: and, even under the *torrid zone*, as was found by thoſe intruſted by the *French* academy, the ſun's heat keeps ſtill inferior to that of the human body (*Vide de calore animal. cap.* 1.) and conſequently to that of moſt of our domeſtick animals, and fowls, which exceed that, according to the above obſervations. The difference among them and that of man, is not at all great; and probably is chiefly owing to the difference of their integuments, which are more apt to foment heat than our naked ſkins: and thus the fowls exceed that of the woolly ſheep, whoſe cover yields in warmneſs to that of feathers, though it exceeds any thing we can contrive, even when we borrow from them; for we cannot implant what they contribute into the ſkin itſelf: and Dr. *Martin*, *prop.* 9. found the urine warmer than the ſkin. And thus we have a very great preſumption, from this equality in the heat of animals, that it chiefly ariſes from the ingredients of which the blood is made up: for to ſuppoſe that it ariſes

chiefly from attrition, by the action of the blood against the veſſels, is giving up all the obſervations made about it; that it differs nothing in the infant from what it is in the labouring ſervant, in the delicate girl, in the lamb, in the ſtraining ox, &c. as Dr. *Martin* has obſerved in the above treatiſe: for nothing can be more different than the force and fulneſs of the pulſe, and conſequently the attrition in all theſe different animals, and in theſe of different ages and ſexes of the ſame ſpecies; and yet the heat is the ſame; nay, the urine, though long ſtagnating in the bladder, is not leſs warm than the blood. We muſt then look upon this heat as the product of the different ingredients of which the white of the egg is compoſed, as they are wrought by the different veſſels and the heat conjunctly. And it ſeems now agreed upon, that the ſerous part of the blood has the principles of the red maſs, but only wants to be further manufactured by repeated circulations and compreſſions, and longer concoction by the heat: and thus, if, ſoon after a meal, a perſon is let blood, you will find that much of the ſerous chyle ſeparates from the maſs, which

which would not be seen some hours after. And if we attend something accurately to what happens to persons of good stomachs after a large meal, we shall be able, distinctly, to judge of the *phænomena* arising from the mixture of the new chyle.

When these begin to dine, we must suppose the intestines, and even lacteals, drained; then eating heartily, in a short time, these vessels are supplied largely, and thence a very great run of new chyle into the veins and arteries, that is, of crude materials; which so far suppresses the heat of the glowing mass: and therefore, as the new mended fire gives less heat, there must of necessity be a suppression of the animal heat for some time; which is found by a chilness immediately spreading over the whole body, and with it an indolence, especially in the winter, when the external cold contributes to chill the mass; and now the fire, and the easy-chair, is sought, till once the blaze gets up, and glows in all the features, and often ends with a degree of moisture: and the person thus affected, we reckon most healthful, and upon good grounds, because it is first the indication of a good digestion,

geſtion, and then of a hearty meal, which happens not to the invalid.

When therefore we advance, that the blood is of much the ſame degree of warmth in moſt of the more perfect animals, it muſt be underſtood, when it is in its moſt perfect ſtate in them: for *Sydenham* has long ſince acquainted us, in his epiſtle on hyſteric ſymptoms, *Quod non rarò notabilis quædam externarum partium refrigeratio, ſymptomatis his omnibus viam quaſi ſternit, et plerumque non niſi paroxyſmo finito depellitur: quam quidem refrigerationem haud ſemel iſti ferè, quâ rigent cadavera, parem comperi, pulſu nihilominus rectè ſe habente:* in which caſe, to be ſure, the thermometer ſhould have ſubſided by their touch, as it does under the cold of an ague, according to Dr. *Swencke*'s account; who, in one perſon, found that then his thermometer, which was of a piece with Dr. *Martin*'s, did not riſe above the 60th degree, though in another to the 87th, but in time of the great heat to 104, and of the ſweat to 100, and when all was over, 95; ſo that this animal heat, ſo equal in perſons of health, differs greatly in the ſame perſon under diſeaſes;

but

but in none more than in perſons under the *chloroſis* or *febris alba*, who have ſcarce the colour of blood, and yet recover it very faſt by bitters and ſteel, with exerciſe, and eſpecially by the uſe of the bark: theſe are ſubject to very feveriſh warm fits, though for moſt part to cadaverous chilneſs. So that in them, and the aguiſh, there is ſomething reſembling the courſe we obſerved in people of health after a hearty meal; an extraordinary heat after obſervable chilneſs and coldneſs: and whether or not it is owing to a like cauſe, a great proportion of crude matter, intermix'd with the maſs of blood, that checks its heat, till it be digeſted and aſſimilated to the maſs, I leave every one to judge from the *phænomena*.

THERE is another vulgar obſervation, which ſeems much of a piece with what we have advanced, and to depend on a like reaſon. If one has been very warm or ſweating, and is immediately expoſed to the cold, he firſt has a feveriſh horror, and then the feveriſh heat of more or leſs continuance: what more probable reaſon can be aſſigned for this, than that, after the external veſſels have

been much evacuated by the force of the heat, they come ſuddenly into an abſorbent ſtate, and introduce a flow of crude juices, which ſtifle for a moment the heat of the maſs. Or this may be accompliſhed (as Mr. *Hales* would have it, *(append. hæmaſt. obſer.* 4.*)* by ſuddenly chilling the humours in the dilated veſſels of the ſurface; as he ſuppoſes to happen to thoſe who ſit long in the open air: for though, ſays he, in that ſtate, we may not be much ſenſible of any cold; yet on our firſt moving, whereby the motion of our blood is alſo accelerated, we are then immediately ſenſible of chilneſs all over us, which is, doubtleſs, owing, adds he, to the very cold ſurface-blood's then running in greater plenty among the next adjoining inner veſſels, which, being much warmer, are then ſenſibly affected with the ſenſation of the much colder blood, from the ſurface of the body; or rather, as we were ſaying, ſtifles the heat of the maſs, and produces a great coldneſs through the whole body, as we reckoned the greater flow of chyle does. And the effects of it, in all theſe caſes, are moſt manifeſt; for on making urine at that time, we find

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it quite limpid; ſo that none of the ſulphureous fumes are then raiſed and carried off with it, ſo plentiful at other times; and a breathleſſneſs is felt, on the want of them, at the breaſt.

We may underſtand, likewiſe, how a ſingle drop of water, upon the warm ſurface of the body, ſhould diffuſe a chilneſs over the whole. For, as we obſerved in treating of muſcular motion, all the fibres of the ſkin are on the ſtretch, and with the ſame *impetus*, by which the *ſtimulus* of the cold drop contracts theſe it touches, we knit and contract all the reſt; this is a copy inducing us to ply the reſt after the ſame manner; and thereby there is a general puſh of the ſurface-blood in upon the maſs, which is not felt when flowing ſlowly, and mix'd in a ſmall proportion with the maſs. And thus, ſudden fear, attended with a ſtrong contraction of the external parts, may chill the maſs.

But though I would argue, in ſome ſuch caſes, for the ſtifling the flame and heat of the blood, by a run of crude or chill'd humours overpowering it; yet I am far from imagining that this is always the caſe: for any thing that will intercept the blood from going

to the extremities, produces a like feeling; being ſo far in the ſame circumſtances with the gangrened limb, through which no blood moves at all: and thus we can never be ſurpriſed to find a cadaverous chilneſs, when the pulſe quite diſappears; as happens upon great loſs of blood, or other evacuations continued, ſo as to drain it greatly: or any other cauſe by which the circulation is weakened; as the abdomen being in too relaxed a ſtate, or the whole ſolids weak, as in the *chloroſis*, *&c.*

But yet there is certainly ſtill ſomething more myſterious in the ſudden productions of a cold chilneſs in ſome caſes; as in theſe hyſteric diſorders *Sydenham* mentions, where, with the coldneſs, the pulſe continued good, and conſequently the motion and attrition took place, tho' not the warmth; and what we ſhall ſuppoſe in theſe caſes, is not eaſy to imagine. But, as natural hiſtory furniſhes us with a variety of examples, (as we find by Dr. *Martin*'s collection, in his 20th propoſition on this ſubject) where the ingredients of mixtures, of themſelves, produce heat and cold, we may juſtly ſuppoſe that the maſs of blood ſometimes meets with ſome

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ſuch ingredients. I ſhall give only one example, from Mr. *Boyle*, where we have inſtances both of heat and cold produced in an inſtant, (his works, *vol.* 5. *p.* 97.); ſalt ammoniac, caſt upon oil of vitriol, gradually produced a ſeeming efferveſcence, with great noiſe and ſtore of froth, which more than once was ready to run out of the veſſel; yet the mixture was cold both to the touch and thermometer; then throwing this into three or four times its quantity of cold water, it turned ſo warm, that the glaſs was held with uneaſineſs. Such inſtances as theſe would perſuade us, that when heat is attended with efferveſcence, yet it is not the neceſſary conſequence of it, ſince cold ariſes likewiſe along with this, and that cold is produced from certain mixtures; ſo that in ſuch as are ſubject to ſudden chilneſs, if no evident cauſe caſts up, it is not abſurd to ſuppoſe, that in a diſeaſed body, where the humours are always changing, ſome of them may ſuddenly chill the maſs, tho' ſuch a cauſe muſt always be very obſcure.

But, from the whole of this hiſtory of the cauſes of the productions of heat and cold

cold in general, and the cafes of the human body where they are produced, it is abundantly evident, that bare attrition can never be admitted as the caufe; and is ftill more evident from examples we have in fevers, of very great heat and drought, and the reddeft urine, with a fcarce perceptible pulfe; of which (this very feafon, *June* 1750) I have had many examples, where I extinguifhed the heat with diafcord and claret; which always turned worfe, by drinking water and watery things; and even with *crem tartar*, which I find a great charm in moft inflammatory fevers. One of thefe patients, who had been toffed with anxiety, heat, and drought, for three days, made me feel his fore-head, while I could fcarce feel his pulfe; and it felt no otherwife, than if I had held my hand clofe to the grate of a large fire. The claret raifed his pulfe, extinguifhed his heat, brought moifture to his parched palate, and a digeftion to his urine; periodical fweatings accompanying the change for fome days, as it did for ordinary this feafon, tho' he kept weak and giddy for fome time after, in fpite of the bark and claret.

AND

And as we find, according to the conſtitution of the ſeaſon, fevers of different degrees running out to different periods, and many of them attended with eruptions of different aſpects and different courſes; what can be more certain, than that, under theſe different *phænomena*, the humours are in a moſt different ſtate, undergo different agitations according to it, and at length have diſcharges of different natures; eſpecially ſince we find that the matter ſo diſcharged, applied to ſome ſound bodies, produces a like courſe to that by which it was produced, while there are others not ſuſceptible of the contagion; as in epidemic diſeaſes, one ſpecies of animals are affected, and not another: Can this be by any other means, than the infectious matter mixing with, and working upon the maſs appropriated to it, and thereby producing an increaſe of heat, &c.? And if an increaſe of heat accompanies theſe agitations, by which ſo many forms of matter are caſt out of the blood, and ſo many other new appearances made; why ſhould we be ſo backward to allow the action of ſmaller particles of matter in the blood among themſelves

ſelves to be productive of heat? If we had any inſtance of pure water, by being agitated, receiving any degree of heat, we might imagine the blood wanted no more. But as this has not as yet been ſhewn, and we have the plaineſt inſtances, even in the body, of a change of mixtures cauſing more or leſs heat, we have all the reaſon in the world to allow, that it is the nature of the parts making up the maſs whence the conſtant heat of the blood is ſupported, and whence its greateſt irregularities are to be accounted for. There is no doubt that the motion contributes to it: but we have ſhewn, that it does not riſe and fall with the motion: and therefore motion here does as little, as preſſure to a dunghill or undried hay, without which they do not heat, whereas it preſerves what is dried; and conſequently, not the preſſure, but the juices of the graſs in a moiſt ſtate, kept ſo cloſe as to make one part act upon another, produce heat. And thus the circulation mixes and preſſes to the ſame purpoſe juices fitted to act upon one another when in contact, and which ſeldom but heat, even after death, when the chilneſs of death is over; which

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new heat is remarkable even amidſt the greateſt heat of the atmoſphere around; for then the air in the body, enjoying its elaſticity when no fumes act, ſwells in every veſſel, and cauſes a very cloſe preſſure of the juices, and hence they kindle: and, in the greateſt health, if you keep two parts of the body contiguous, they heat and ſcald. Nothing is ſo active as the different parts of the blood. The perſpiration, or any other part of it, kept cloſe upon the animal body, is apt to propagate itſelf. Itch produces itch, pox the pox, and, in many caſes, infected perſpiration, the diſeaſe whence it was infected. Is it any thing ſtrange, then, that the warm blood ſhould bring the chyle into the ſame degree of heat, after being contiguous with it for ſome time, ſince moſt of it is animal juices, and the reſt fermentive juices of vegetables? All of them have the principles of heat in them, and very ſoon warm when kept cloſe together, eſpecially in a warm place: and though the hot-bed, after coming to a certain heat, gradually cools again; yet it would never do ſo, if recruited perpetually with new materials of a like nature, as we

find the blood to be; which yet can be long preſerved with no recruit in ſome caſes, without loſing quite its heat: but then it preys ſomewhat on the body; which turns parched and dry in theſe caſes, but not putrid, as has been ſuppoſed: as we found in the caſe of the young Lady mentioned in the firſt Eſſay; who, after faſting compleatly two months, and living ſparingly for ſix months more, under the ſevereſt exerciſe of her muſcles, nevertheleſs had no ſtinking breath, no high-ſmelled urine; this, amidſt all theſe ſevere agitations, keeping quite limpid, and ſhe herſelf rather cold than warm, though her pulſe was generally full. So that, in her caſe, we had the ſtrongeſt attrition I ever had an inſtance of; but no extraordinary heat, no ſign of putrefaction: the more ſulphureous parts were much ſpent in her, and ſhe ſeemed to have no recruit, but what accrued to the maſs from the cellular ſtores laid up in health, or from the air. And, in the young man of a good firm conſtitution Dr. *Martin* ſpeaks of, *prop.* 18. the heat decreaſed four degrees on two days faſting, from the want of new chyle, and not from a leſs quantity of blood.

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Therefore, not the ſtrength of circulation, but certain mixtures with the blood, ſeem the great cauſe of putrefaction in it; as the daily recruit of wholeſome food keeps up the ferment and heat. And hence, in priſons, ſhips, and hoſpitals, not well air'd, the moſt putrid fevers are found, eſpecially when the ſeaſon is ſultry-warm: and many ſores do not ſhew their worſt till laid open, and an acceſs made to the air to work upon them, as in cancers, gangrenes, and ſeveral others. Nothing, then, ſeems more ſuſceptible of contagion, more diſpoſed to be wrought upon, to be agitated, to ferment, than the blood: nor is there any fluid that ſhews more different products, as we have already obſerved, than the blood does under theſe courſes; and medicine muſt be greatly defective, while we are defective in their hiſtory. The antients laid themſelves out greatly to obſerve the periods and criſes both in acute and chronical diſeaſes, and to aſſign the marks of the more or leſs promiſing, to teach the Phyſician when and how far he ſhould interpoſe; and *Sydenham*, with great ſagacity followed the example. But the extravagancy of Chymiſts, in introducing what was obſerved only in their phials

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and retorts, whereby to judge what paſſed in the body, brought this method greatly in diſcredit, and made way for the Mechanicks to eſtabliſh their empire, which was not able at all for the government: and therefore it cannot be ſurpriſing that the commonwealth of medicine flouriſhed ſo little under their abſolute authority. Mechanicks, then, and Chymiſtry muſt be joined, if we would ſee and judge of what paſſes in the body: and we muſt be ſure of ſuppoſing no power, no active matter, to be employed, but what in fact has been diſcovered preſent; in which caſe we ſhall enlarge Chymiſtry in its bounds, and Mechanicks, by introducing under them many things found in the body. But we muſt beware of eſtabliſhing any thing found with Chymiſts and Mechanicks as part of the animal œconomy, which we have not been able to trace in the body. All things from analogy, muſt be introduced with the greateſt caution. We muſt ſee the inſtruments we bring into our operations ſo diſtinctly, as to be able to deſcribe them; and then we may be ſure we impoſe not upon ourſelves or others. And thus, after the trials made of the heat of the

the blood, we are confident of its degree, and of its equality in the moſt of men in health; and, by the ſame trials, we find how it varies in diſeaſes, and what *phænomena* go along with its changes: and to it, and the matter it works on, we attribute both the quantity and nature of the perſpiration. Since the heat of the blood is greater than that of the ſun in the dog-days, and the blood itſelf at leaſt twice more volatile than water, as we ſhall find afterwards; and as nothing is more porous than our ſkin, the evaporation muſt be very great: and as, by many experiments, this evaporation is found inflammable, it gives us a pregnant proof of the nature of the whole maſs; that it is a bituminous fluid, ſeething conſtantly with a degree of heat about half that of boiling water, according to Dr. *Hales*'s calcul, *exp.* 10. *Veget. Stat.* and Dr. *Swencke*'s, who makes boiling water 212 in *Farenheit*'s thermometer.

This heat, then, muſt have different effects on the concoction of every different humour according to its nature, and as it lies more or leſs near the larger ſtreams of the fixed maſs; and hence its uſe in the body muſt be various,

various. To this in particular we muſt refer the aſſimilations of the chyle to the maſs; the turning the acid fixed ſalts to the volatile neutral, as we find them in the urine, *(Vide Diſſert. on the urine)*, and in the maſs itſelf; ſo that there is here a true chymical change, and with this change the ſulphureous or oily parts are greatly exalted. A friend of mine, to ſatisfy himſelf of what *Hoffman* and *Swencke* advance upon this head, ſetting blood and water in ſimilar veſſels, equally filled, in the ſame window, found that not above a fourth of the water was evaporated, when an half of the blood was gone; that in 48 hours it was reduced to an extract, and in 72 to the conſiſtence of glew; and this, dried to a cake, and powdered, according to Mr. *Boyle*'s obſervations, flaſhes like roſin through the candle's flame: ſo that the whole maſs ſeems to be moſt volatile and ſulphureous. And, in our treatiſe of reſpiration, we have obſerved the effects its fumes have upon the air admitted to the cheſt, and that no ſuch thing as reſpiration could be without them; at the ſame time, the air in every other cavity and veſſel is kept at under, which otherways, by the

the degree of heat that acts upon it, would burst every vessel; as it does in some degree in the corpse, when there is no check by fumes.

And the nervous juice evaporating in every bowel, by the same heat, must make a great demand upon the brain; as the evaporation by the leaves of plants and trees makes demands upon their roots, according to Dr. *Hales*'s observations. And thus, all along the pulpy substance of the nerves, we see a necessity of a perpetual run of the nervous juice, which we cannot conceive should happen upon any other supposition: and thus the heat of the blood is as necessary to promote the nervous juice, as that of the sun to bring the juice of plants into action. But if the brain, the source of the spirits, is drained, then the heat has no right materials to act upon; and hence every part turns languid, though the heat is in vigour. And thus it is we are disposed to rest and sleep, and continue so, till the brain is furnished with stores for the service of another day. And, from the same reasoning, we understand why sleep accompanies the greater degrees of cold: and,

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on theſe views we muſt allow, that *Harvey* could not have given the blood a juſter character than the *ſol microcoſmi.*

I have often obſerved, that people ſubject to periodical fits of the *mania,* as a prelude of the fit approaching, have complained of a weight and fulneſs about the *hypochondria,* and of a more intenſe redneſs in their urine, which, at the height of the fit, after laſting ſome weeks, came to be as dark as that of claret; and going off yielded a copious dark ſediment, not unlike what we find under the jaundice; which confirmed the notion of the antients to me, that the ſeat of the diſeaſe was certainly about the *vena portarum,* and the veſſels immediately communicating with it; and that the blood there ſuffered great changes; which was confirmed by theſe medicines only being ſucceſsful in removing the illneſs, which chiefly operated on theſe parts; whereas the cephalic medicines ſhewed no good effect. Now the queſtion is, what force the blood or humours in theſe parts, of whatever nature we ſhall ſuppoſe them, could have in diſturbing the mind, in turning its ſtate to a ſtate of viſion,

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to hear, ſee, and feel things ſo different from what actually paſſes before them or is tranſacted, as happens in many other caſes. To judge of them, we ſhall take ſome of the moſt ſimple examples, where the cauſe is certain, and the remedy. One of theſe I take to be that of getting drunk. Let a perſon be fuddled with ſpirits, how does it change his thoughts? he raves, and becomes a madman; pour into him ſome draughts of water to dilute the ſpirits, and extinguiſh their heat, at once he is himſelf again. Wherefore it is manifeſt that, in this caſe, it was the fiery ſulphureous blood whence the heat and all the diſturbance aroſe; and that, by augmenting the quantity of the watery parts, the heat was extinguiſhed, and the wild fancies with it; while we cannot eaſily ſuppoſe that the nervous juice was changed. But how ſhall we determine whether blood in this overheated ſtate, immediately by itſelf perverts the fancy, and leads the mind in a train of errors; or whether it firſt acts upon ſome ſenſory more intimately connected with the ſoul? For my part, I cannot find why we ſhould reckon the mind worſe to be affected by the

blood of itſelf, than by ſome ſenſory diſordered by it; eſpecially as we find it certain, that the mind of the mother affects the child in the womb, though there is no communication of nerves between them: and though we have ſenſories appropriated to form certain ideas, as of ſound, light, and colours, *&c.*; yet I know none for ſenſe and reaſon; tho' if there were any, we could not but expect, they ſhould be as complicate and conſpicuous as the others. That all the ſenſes by which we have certain ideas excited, are diſturbed with the blood, there is no doubt; and this certainly muſt confuſe the mind greatly: but how from this a man turns more penſive, frolickſome and furious, ſhould converſe with perſons not preſent as if in view, *&c.* cannot be explained from any change of the ſenſes: and therefore though the mind falls into ſome miſtakes from the ſenſes, yet this thorough perverſion of the mind, muſt be from ſome other ſource: we muſt allow, while the houſe is in a flame, that the mind is bewildered in the ſmoke; and that as it is intimately joined with every link of the muſcular fibres, ſo it is with every drop of the fluids, and has

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certain ideas from every different motion in them; fries with the bile, with the *ſaliva* of mad creatures, and turns ſtupid, moroſe and ſenſeleſs, with a leſs volatile maſs. The unmanageable bull, perpetually roaring with fury, upon checking the mildeſt ſecretion of his body, and what lies at the greateſt diſtance from the brain, becomes the obſequious and mild ox. I don't pretend to be diſtinct in this affair; but would ſtudy to ſay ſo much of it, as to fix the Phyſician's attention to it; ſince, by rectifying the maſs, and being attentive to other places than the head, in ſuch diſorders, it is poſſible we may come to have a greater command over them, than has yet been imagined. For I have often found, that, by the eaſieſt methods, I have compoſed ſuch diſorders; when the green withes to tie them, or the whip to chaſtiſe them, with bliſterings and cuppings of the head, had been idly applied.

Take all the effects of the warm blood together, then, it muſt appear a very myſterious fluid: its ſtreams accompany every nerve, and facilitate the courſe of their fluids; and thereby invigorate every part of the body: on

on its ſtop, all ſtrength and nouriſhment ſtops, the parts gangrene, *&c.*; by its fumes, the machinery of the breaſt plays and changes an hundred ways, the air ſhews different powers within every cavity and veſſel; and we have juſt ſaid how much they affect the fancy: no wonder then that *Harvey* could ſcarce imagine it different, not only from the vegetative, but the active directing ſoul itſelf, as we find in his treatiſe, we cited, *de calido innato.* But what he and others have ſaid, only ſhews, that there is ſomething more wonderful in it than has yet been diſcovered diſtinctly; and that a further attention to it, may greatly enrich both the theory and practice of medicine, beyond what the mechanick Philoſophers will ever be able to make out.

Besides the ſulphur which remains in the blood after calcining, *M. Vincentius Menghinus* mentions a great portion of iron particles, eſpecially in the human blood and quadrupedes, ſome in fiſhes, and fewer in fowls; how much theſe contribute to ſupport the heat of the blood, I leave ſuch to conſider

who

who know the ingredients in the *thermæ*, though vegetables abound in them likewife. *Vid. Inftitut. Bonon. part* 2. *vol.* 3. and *Medical Effays*, *vol.* 2. *art.* 6.

Upon the whole, we may make the reflexion *Galen* has, *edit. chart. vol.* 10. *de Hirud. cap. ult. circa fin. Nam fæpius in anno venam fecare haud expedire arbitror; quod una ex fanguine vitalis excernatur fpiritus. Atqui fi hic copiofius abfumatur, tota moles refrigeratur, et omnes naturales operationes deterius perficiuntur.*

For a particular anfwer to their opinion, who deduce the heat from attrition, I muft refer to Dr. *Stevenfon*'s excellent treatife on the heat of the blood, in the *Medical Effays*. I have faid nothing of the globular form the leffer particles of the blood have been obferved to move in, by microfcopes, and to which it refolves itfelf: I reckon the blood has this form in its compounding parts in common with moft fluids; which Mr. *Lewenhoeck* would have overlooked in the blood, if he had not difcovered it before in the yeft of wine and ale; as he acquaints us in the 2d epiftle of his works; though they form

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more regularly in the blood, as they do in every oleaginous fluid; Sir *Isaac Newton* having obſerved the attractive and refractive power of bodies, to be greater or leſs, as they partake more or leſs of ſulphureous oily particles, with which we have ſhewn the blood to abound. What ſeems more nearly concerned in its hiſtory, is the perſpiration and urine, two ſecretions on which its right ſtate greatly depends, and which help to form juſt indications concerning it; and therefore, to complete its hiſtory, we ſhall ſubjoin ſome account of them.

Of Perſpiration.

THIS ſeems to be an evacuation, without any particular *apparatus* for it: at leaſt every porous body is ſubject to a like diſcharge from ſimilar cauſes, that is, from heat, and a ſupply of volatile matter; and no body can be more porous than the animal, M. *Lewenhoeck* having calculated, in the ſpace of an ordinary grain of ſand, no leſs than 125,000 of them; which there is no reaſon to ſuppoſe to be the extremities

extremities of regular veſſels, but the interſtices along their ſides; at leaſt we find, that the inward ſurfaces of the cavities of the body, and the ſurfaces of the bowels they contain, have the ſame perſpiration which ſtrike our ſmell, upon the cavities being laid open, while a cloud of vapours ariſe from them, and they inſtantly abſorb liquors injected among them: nay, we ſee upon bruiſes, that the blood under the ſkin is gradually abſorbed; and, according to an obſervation of *Galen*, cited by Mr. *Boyle*, in his 6th chapter of the porouſneſs of bodies, blood extravaſated in fractures, where the ſkin had not been rent, penetrated it ſo as to appear upon the dreſſings. Whence we would imagine, that from every ſide the ſkin was permeable; as the ſame Gentleman found the bladder, by putting ſalt of tartar well dried into it, and tying it up when quite free of all moiſture; for in that caſe, he found, when the bladder was left in water, the ſalt ſoon diſſolved; and even ſugar managed the ſame way, though it diſſolved ſlower. As *Hippocrates*, then, long ſince aſſerted, the body is every way permeable, and, as it would ſeem, perforated, as is

every

every veſſel: for how can we ſuppoſe membranous and fleſhy parts not to be porous, when we find the hardeſt bones, and ivory itſelf, to abound with them? as is ſhewn by particular experiments in Mr. *Boyle*'s eſſay we have mentioned. The body, then, abounding with fluids, every fibre, though not vaſcular muſt be moiſtened by them through and through, as a ſtring of hemp or lint will be, if you dip but any one part of it into water, eſpecially in a warm place.

And thus we conſider the whole body as one porous lump, ſapped in its own fluids, and glowing with 96 degrees of heat, according to *Farenheit*'s mercurial gage, when not chilled by external cold or diſeaſe: in which view, we muſt be ſenſible that it muſt perpetually emit clouds of ſteam; and, agreeably to this, it is found in ſummer, if one ſits near a white wall, enlightened by the ſun, with his head new ſhaven, that the ſteams ſhall be diſcovered by the ſhade on the wall. And, from this account, there are three great cauſes of this perſpiration, the heat, the quantity, and the volatility of our humours.

None can doubt but the matter perspired must always bear a proportion to the heat; and, consequently, cold on the surface of the body must check it considerably; heat being the known cause of raising and carrying off steam from fluids, as Mr. *Hales* has shewn by repeated experiments in vegetables. If this had been adverted to, we should not have had so much talked of the effect of cold closing the pores of the body. Let the pores be as open as you will, there must always be heat to raise the steam; and that will always find pores to favour its course.

We took notice, when treating of the blood, of its great volatility in respect of water; so that we must look upon it as favouring a great discharge when exposed to heat; and that according as it is more or less crude, or as it has had supplies that more or less favoured its volatility. And thus it is observed by Dr. *Keil*, and others, who have made statical experiments, that though in those who live uniformly the perspiration keeps something equal; yet it is found very different in different persons, according to their temperament, age, food, sleep, exercise, and season

of the year ; and all theſe, either as they change the heat, or more or leſs promote digeſtion, and a juſt quantity of fluids ; agreeable to which we find the whole of Dr. *Keil's* obſervations.

THUS, in *aph.* 15. he tells us, the perſpiration is in proportion to the heat in the ſame circumſtances : agreeable to which, he found that the greateſt ſummer perſpiration through one day, was double of the leaſt winter perſpiration, as in *aph.* 17. : that coming out of the hot bath, an hour's perſpiration was not leſs than 24 ounces, *aph.* 25. ; whereas ſitting in a cool place, it was not above half an ounce in that time, *aph.* 23. and, by heat and exerciſe, only four, and ſometimes leſs, *aph.* 21. : ſo that heat and moiſture joining make the greateſt ; whereas chaffing the ſkin made no change, *aph.* 33. : and though bathing promoted greatly the perſpiration, yet drinking ſmall liquors did it not ; and therefore perſpiration in the firſt caſe was certainly owing to the more external parts retaining much moiſture, which the heat ſoon diſpelled again.

AND

And as it rises by heat, and consequently exercise, and every thing causing heat; so it does by certain foods, some supplying more, and some fewer volatile parts, which recruit the mass more whence the perspiration flows: for since we found, in our essay on the blood, that it was greatly more volatile than water, it will be more or less so, as it abounds more or less with water, in regard to its other parts, or any other thing less volatile, or curbing what is volatile. And thus Dr. *Keil* observes, that, by eating oisters, he perspired less than when he eat nothing at all. But, more particularly, the tables which Dr. *Rogers* of *Cork* published, shew, that, even in summer, with the advantage of heat, lettuce, mushroms, melons, cucumbers, purslain, diminished the perspiration a third, as did the rest of the slimy, watery, vegetable kind of food: and it is greatly diminished likewise by pork, new cheese, bread not well fermented, ryce, as it is by soles, eels, oisters, and fish of a like nature; while it is greatly favoured by well baked and fermented bread, fresh eggs, honey, mutton, partridge, woodcock, plover, turkeys, capons, pullets, and the like, wines

of

of ripe fruit, well wrought ale, *&c.*: ſo that there is the greateſt odds in it, from the *pabulum* with which the blood is ſupplied.

If, then, conſtitutional aſthmatic patients are made ſo by a defect in their blood, by not having ſtore enough of volatile parts to keep it under the elaſtic air in the veſſels, as we ſuggeſted before; then we ſee what air they ſhould chuſe, and what food. But to bring this to a further demonſtration, many more experiments muſt be made with this view.

We ſhall cloſe up this treatiſe, by confirming what we obſerved before, of the great volatility of the blood in the ſound body, from an experiment we have often repeated; that the ſhirt through which we perſpire odds of a pound in the night-time, gains not one grain of weight in that time; nay, not after being worn three days and nights together: ſo that the perſpiring matter muſt fly quite off even through our cloaths.

Of

Of the Urine.

IT is abundantly evident, that, in general, the ſecretions are made in veſſels where the red blood does not enter, though we know that many of them are thicker and more groſs than it is; as the cyſtic bile, *ſemen*, *mucus narium*, *cerumen auris*, *&c.* But all theſe acquire their thickneſs after the ſecretion in the finer veſſels; and it may be preſumed, that the nearer any ſecretory veſſel is to the greater artery, and the leſs diminiſhed in its wideneſs, that the ſecretion ſhould be leſs changed from the qualities it had when carried along with the maſs: on which account, it is not a little probable, that the urine has changed but little from the ſtate it was in before the ſecretion; and therefore is one of the moſt proper ſtandards to judge of the ſtate of the maſs.

THE emulgent arteries, we find, from inſpection, are the largeſt branches of the *aorta*, and ſeparate from it by an acute angle; and though, upon entering the kidney, they ſuffer great circumvolutions in their branches, which

which are every where reflected into veins, so as to allow all the red and weightier parts, keeping the *axes* of the vessels, to return; yet we know, that any extraordinary shock forces in red blood even into the secretories and excretories; that injections penetrate the same part, which is not found in the other glands: and therefore it is justly presumed, that in so patent a way, and so very short, small changes happen to the passing fluid; and consequently the urine may be looked upon, not as transformed, but as the part of the *serum* which coheres the least with the mass, while what coheres more, passes with it by the veins; the small distance from the *aorta* and openness of the vessels not favouring their separation: whereas, where the course of the red blood is much retarded before it reach the secerning vessels, as in most of the other glands, the mass of itself will resolve, and take on it the serous form, as when extravasated; for then, when kept in a moderate heat, it resolves almost quite into *serum*, though not in the cold, as Dr. *Swencke* observes: in such cases, then, the secretions are made from the resolved mass, while the urine is from the

more

more loofe and unfocial *ferum*, which had not united to the mafs, or had corrupted by its long fervice. And thus we find how this organ is fitted to cleanfe the blood of what was ufelefs and pernicious: whereas the other glands change parts of the mafs into liquors of different natures, as the fervice of the body requires: thefe are made to change; that only to feparate.

After this view of the organ, by which the urine is feparated from the blood, it cannot appear ftrange, that the urine fhould have been fo much confulted, both by the antients and moderns, to form a notion of the ftate of the blood: for as it is the immediate offfpring of the *ferum*, very little changed, by which we may rightly judge of the ftock; fo it has in it all the moft heterogeneous parts which are not fo apt to affociate with the mafs. Thus the bile, which, after its formation, acquires a very different confiftency from the blood, and degree of acrimony, when denied paffage to the inteftines, runs off in great quantities by the kidneys, and makes the urine look as if it had got a mixture of claret, though the cloth dipp'd in it looks

looks yellow, and caufes immediately a very copious fediment; a great proof that the fediment is made up of heavier parts, which do not fo eafily affimilate to the body of the urine. The fame way, let a man have the courfe of his perfpiration ftopp'd, by being in a cold damp *medium*, and we will fee the fulphureous parts that fhould have gone by it, changing the colour of his urine: fo that its ftramineous colour fhall now, even in the ftream, appear, when running, changed for one of a much deeper tincture; and, catched in a glafs, fhall foon become of fuch a muddy clayifh look, as when tincture of caftor is mixed with any fimple water; with which it does not fo intimately mix, as the caftor had done with the fpirit. Now the caftor is a fat or fulphureous animal fubftance, and of the fame volatile nature with our perfpiration; and fhews greatly that *phænomenon* of our perfpiration confounded with urine. The *ftimulus* of this retained perfpiration in the blood moft ordinarily raifes a fever, as in the urine it caufes a *micturitio*; and then this fever an increafed perfpiration, which is always proportioned to the heat: and with it

not

not only the more volatile parts fly off, but every thing that is more fluid; ſo that the blood is thereby greatly deprived of the watery parts, the maſs rendered thicker, and the *ſerum* leſs in quantity, and of conſequence muſt yield leſs urine, which will therefore continue longer in the paſſages expoſed to a greater heat. And thus new colours appear in the urine; for now it gains, according to the degree of the fever, that degree of intenſeneſs in colour, *Bellini* obſerved to ariſe in urine according to the evaporation of the aqueous parts by heat, till it comes the length of the colour of red ſtrong ale; which it has in the higher fevers. Thus we ſee in what ſhape the ſtopp'd perſpiration at firſt changes the urine; though the after-changes, in conſequence thereof, ariſe from the fever, and too great a perſpiration: ſo oppoſite are the changes happening in the body from one and the ſame cauſe! And thus, according to Dr. *Swencke*'s obſervations, if blood be let in a very cold place, it has no *ſerum* ſeparated; in ſome ſmall degree of heat, by degrees the *ſerum* ſeparates fluently; if in a place near to the heat of our blood, of 92 or 94 degrees,

the *ferum* feparates in a fmall qnantity, till it putrifies; but in a degree of 48, it coagulates; and raifed to that of boiling water (212) $\frac{7}{8}$ of it fly off in vapour; fo different are the effects of heat in the different degrees therof. So that *Bellini*, very juftly, after putting it to the trial, made the evaporation by heat, the great caufe of change in colours happening in the courfe of a fever; and confirmed it greatly, by fhewing the firft colour gradually recovered again, by gradually diluting it in water; and when the urine is thick, and increafed in toughnefs, we find no fediment; and therefore reckon it and the blood, whofe interpreter it is, to be then in a ftate of crudity or indigeftion: but when our drink, for which there is a great demand, incorporates with it throughly, fo as to dilute the whole mafs, and render it quite fluid, then the urine is fo in proportion, and with its pale afpect, and copious fediment, fhews the approaching change in the fever; and the fame fever, in different perfons, for moft part, takes the fame time to fhew this; which fhews, that crudities, according to their caufes, require limited times to digeft; and would

argue,

argue, that, befides ftopp'd perfpiration, there muft be a variety of fpecific caufes, which procure epidemic fevers, or that vitiate the blood. But, in any of them, we find feldom a refolution without the figns thereof appearing in the urine; which fhews how much the humours are affected in fuch diforders: and as we find the effects of ftopp'd bile and perfpiration in the urine, fo it is not to be doubted, but every other fecretion ftopp'd, caufes grofs parts to regorge into the mafs, and fupply the urine with heterogeneous parts, which will fubfide: and thus we find, under any fwelling or tumor, where-ever it is, the urine always with an obfervable fediment; as blood let in the fame cafe generally fhews the gelatinous tough furface; and confequently every new difpofition in the *ferum*, which furnifhes the urine, always makes it fhew a new face, and for moft part a fediment, occafioned from the blood's not having a free courfe, under which only it digefts into an equal homogeneous mafs: *pus* too, drawn up into the mafs, and not eafily mixing with it, has got vent by the kidneys, as do fmall liquors

taken

taken in great quantities, which makes them not eaſy to be aſſimilated and incorporated with the maſs.

But then the veſſels of the kidneys, under ſome diſeaſes, manifeſtly change their dimenſions; and in that caſe it cannot be ſuppoſed that they ſhould act as in their natural ſtate: thus, after long habitual drinking, eſpecially of the weaker liquors, a *diabetes* takes place, under which the milder part and leſs diluted of the *ſerum* paſſes, and very ſoon exhauſts the perſon; as I ſaw in one, after long ſtoppage of one of his kidneys by a ſtone, who paſſing about half a pound every hour, was in two days exhauſted in ſpite of the moſt aſtringent medicines. By a violent agitation of the blood, under ſevere exerciſes, blood itſelf has been forced this way: and under convulſions, or even the milder contractions of hyſterics, nothing but the more watery parts will paſs. And thus we find how the urine changes with the maſs of blood, and with the veſſels of the kidneys.

But further, a great many changes can happen from other operations on the organs concerned in the forming and tranſmitting the

the urine. Dark water, as tinctured with ſoot, named ordinarily moſs-water, generally attends a ſtone in the kidney, and ariſes from the oozing out of ſome blood from the ſmaller veſſels grated by the ſtone, and heated along the paſſages; as the blood from the upper parts of the inteſtines loſes its colour, and becomes black, eſpecially if from the liver, when it has the name of *atra bilis.* But a ſtone in the bladder has generally a ſlimy urine from the *mucus* of the bladder, if not pure blood, when the attrition is greater; and the pain in making water is at the beginning, and ſometimes at the end; whereas from an ulcer it continues all along, and you have *pus*, blood, filaments, *&c.* according to the ſtate of the ulcer; to be known from the preceding ſymptoms, and the preſent appearances. In forcing a ſweat, either from exerciſe, warm bath, or medicines, you have urine like what we obſerved to ariſe from tincture of caſtor; and from being abroad in the cold, at firſt we have the watery and pure, as under convulſions; though afterwards what ariſes from ſtopp'd perſpiration.

As to the chemical productions from urine, *Boerhaave* has ſhewn trials in his *Chemy* he made on urine paſſed 12 hours after neither eating nor drinking: this urine, he informs us, had nothing acid in the taſte or ſmell; and theſe things which turn acids reddiſh, made no ſuch change on it; nor did diſſolved ſalt of tartar raiſe any agitation in it, nor the moſt alcaleſcent ſpirit of *ſal ammoniac*: and even the urine of a perſon 12 hours after he had been drinking Rheniſh wine, and ale ſomething turned, and uſed vinegar to what he was eating, and eat ſummer fruits, ſhewed no ſign of acidity in it; as it did not in ſickly girls living on milk and acid vegetables; nor did any ſign of the *alcali* diſcover itſelf by the addition of vinegar, limon-juice, ſpirit of nitre, of ſalt; nor did it make green the juice of plants, as all the *alcali's* do: and this was obſervable even in the urine under inflammatory diſeaſes, long retained, and made in a ſmall quantity: and he had occaſion to examine urine which had been ſuppreſſed 120 hours, which yet diſcovered nothing of the alcaline nature, though he found it in another; and allows, that when

urine,

urine, on any account, is made to putrify, that then it turns alcalefcent. But then this is not in the natural ftate. The falt of urine is therefore a neutral falt, and with it is joined fome fea falt, that never changes in the body. And thus we find that urine is a part of the changed and digefted humours of the body, which have acquired a nature peculiar to themfelves, when retained a competent time. All of this hiftory is confirmed by Dr. *Brown-Langrifh*'s experiments upon the urine, in which he has ufed great diligence; for in a great many trials made upon urine from perfons under fevers, he could not, before diftillation with a ftrong fire, find any appearance of alcalefcency, except in his 4th and 5th experiments; and even in this cafe the appearance was very fmall, tho' the heat had been extreme, as well as of a long continuance: but he acknowledges it was a fingular inftance, out of a great many under ardent fevers, where he could not find another; and concludes his obfervations, that, in his 5 trials on the urine of a young woman, where the fever was fo high, the urine became more and more impregnated with faline and fulphu-

reous

reous parts, in proportion to the abatement of the bad ſymptoms, till at the *criſis* it contained more than double the quantity it did before; which diſcovered a plain digeſtion and reſolution of the maſs, too much coagulated, or cloſely combined, under the ſtrength of the fever, when examinations made on the maſs, and urine, would have ſhewn a great difference of principles; the urine, in that caſe, having a ſmall ſhare of them. And thus we find, in moſt of theſe caſes where Dr. *Langriſh* examined the coheſion of blood in his patients under fevers, that the urine was limpid, while the *ſerum* was deep coloured and pungent, and the blood ſtrong in its coheſion. In others it was indeed otherways; particularly in his laſt caſe, where the urine was lixivious, and the *ſerum* exceeding pungent, and of a deep bilious colour, and there was a vaſt coheſion in the maſs: but, as this was in the 13th day of the fever, it is poſſible it might be under ſome remiſſion: for, in ſome of the worſt fevers with remiſſions, I have ſeen urine, which in other caſes would have promiſed well, attend the worſt turns; at one time with the fulleſt ſediment,

diment, and the next limpid without any at all, having the appearance of many partial *crifes*; but, in the mean time, carried off the patient. From thefe obfervations, it may be allowed, that the urine gives generally a good indication of the ftate of the blood; and that, with an ardent heat, limpid water is a great indication of a ftrong cohefion of the mafs; which continuing, kills the patient; but digefting under the actions of the body, and fuitable drinks, refolves at length, and gives an agreeable *crifis*. The whole of the proceffes in the cafe, fhew that it is the humours which caufe and fupport a fever, and muft alter, therefore, greatly according to that ftate, or according, if you will, to the infection. For as an hundred things may infect, fo we may have an hundred different fevers, where the courfe and times of digeftion fhall be moft different; which confirms greatly the hiftory we gave of the blood.

As to the particular fituation the kidneys have got, if we confider that the bile is the fharpeft of all the fecretions made from the blood returning from the fpleen, ftomach, *pancreas*, *omentum* and inteftines, we may fee

the reaſon why neither ſalts nor ſulphur was to be ſeparated from the blood that was to ſupply it; and therefore the ſeparation of the urine would have been diſadvantageouſly made before the bile, or what ſupplies it; and it would have been as diſadvantageous to have had blood unpurged to ſupply the ſpermatics, whence the mild balſamic *ſemen* was to be ſeparated; and therefore, immediately after the emulgents, the ſpermatics ariſe.

ESSAY

ESSAY V.

Of the Brain.

IN the former Sections, we have considered those actions which properly deserve the name of the VITAL in animals; those actions, I mean, which are immediately employed in carrying on the circulation.

BUT as, together with such actions, the Physiologists generally consider that of the brain, we shall not dissent from them in the method: for though we did not find any necessity to consider the brain as having any direct influence in moving any of the parts concerned in the circulation; as, in our opinion, it has not in moving any other part; yet as the vigour of the whole body, and consequently that of the parts we have described, depend so much on the brain, that for the most part they suffer immediately with its misfortunes, we shall give it a place among the parts immediately concerned in the vital actions;

ons; for the conſideration of which we have deſtin'd theſe eſſays.

The firmneſs of the walls with which the brain is invironed; the ſudden and fatal effects which frequently attend its diſorders, particularly in ſtupifying, and otherways diſtempering the mind, to appearance; and then again the life and ſpirit diffuſed over its frontiſpiece, the face, and the number of ſenſories round it, which ſeem, as *Cicero* ſays, as ſo many avenues leading to the ſoul; have greatly perſuaded Philoſophers and Phyſicians of its excellency and dignity: though I ſuſpect much, that none of them as yet have diſcovered truly where its excellency lies; and that, in attempting to ſhew it, the opinion of its myſterious powers has ſo prepoſſeſſed them, that they have been carried beyond both Anatomy and Philoſophy in their ſpeculations. Whereas, if they had allowed themſelves to have been conducted by Anatomy, the only ſure guide in explaining the animal œconomy, they would have found nothing but what is ſimple and plain, and moſt conform to what they meet with in the other quarters of the body. For my part, at

leaſt,

leaſt, I can find nothing, nor can I learn that others have found any thing in the whole extent of the brain, except the vaſcular and fibrous productions of the blood-veſſels, as in other glandulous parts, and the membranes neceſſary for their ſecurity and convenient diſpoſition. What more than this has ever caſt up to *Willis*, in all his ſcrutiny with the knife? what more to *Malpighius*, however laborious with his glaſſes? what more to *Ruyſch*, with his ſubtile injections? to *Morgagnius* and *Winſlow*, though provided with *lyncean* eyes, and minds ſcarce to be impoſed upon? All theſe great and laborious Gentlemen agree in the uniform ſtructure of the conſtituent places of the brain; though in different parts they are diſpoſed differently, as are the parts of the moſt uniform bowel we find in the body.

If our inveſtigators had found any various machinery about the brain, formed ſo as to ſhew the ſmalleſt appearance of different organs, they might have been indulged the liberty of imagining, that one part was ſubſervient to memory, another to judgment, &c. But for them, with that great Naturaliſt Dr.

Hook,

Hook, to ſuppoſe in the brain ſome kind of *Bononian* phoſphorus, to receive the impreſſions of the light from the eyes ; and in another place vaſes or bells, like what *Vitruvius* mentions to have been placed in the antient theatres, to receive and return the ſounds more vigorouſly, is making our fancy to conſtitute the brain, and a plain diſregarding of what it is in itſelf; which, as I ſaid every Anatomiſt allows to be as ſimple in its ſtructure as any other gland, and as uniform in its parts.

In its different parts, I acknowledge, this homogeneous ſubſtance of the brain is differently diſpoſed; but no where in ſuch a manner, that one can be led to ſuſpect that any of its parts are employed as any particular machine or inſtrument whereby to convey to the mind any particular perception or ſenſation, or make its acceſs eaſier to move the other parts of the body. This difference in the ſituation of the ſeveral parts of the brain, ſeems plainly calculated for the ſafety or convenience of ſuch a bulky maſs. Thus the *cerebrum* is in one repoſitory, the *cerebellum* in another, and the ſpinal marrow in a third; though

though they communicate one with another, and their ſubſtance ſeems quite ſimilar. But as the *cerebrum* was ſtill too bulky for ſo ſoft and incoherent a ſubſtance, expoſed to violent ſhocks, we find it ſtill parcelled out into leſſer parts, ſecured ſome how from the ſhock of their neighbours. Thus we find it ſeparated into the anterior, poſterior, and lateral lobes: but the middle part being ſtill too bulky, it is moſt artfully diſpoſed of, made hollow in the more centrical parts, and vaulted, and divided by a middle partition, and arched where it terminates at the poſterior end; and the floor of this vault is emboſs'd with various riſings, allowing veſſels of different kinds to run among them, and a variety of conduits or drainers to the whole; while under all theſe different forms the matter ſeems quite the ſame; for, except the blood-veſſels, nothing is found among them but the cortical and medullary ſubſtances common to every other part of the brain and ſpinal marrow.

AND thus I am as little ſolicitous to find, why the *glandula pinealis* is left ſolitary, as I am about the *lobus parvus* of the liver: nor

am I more ſolicitous about the *corpora ſtriata, thalamus nervorum opticorum*, and *quadragemini* of Mr. *Winſlow*, than thoſe of the brow, chin, cheeks, mouth and noſe, which indeed add to the ſymmetry of the face, but could not but be ſimilar, ſince the parts on each ſide are the ſame, as are thoſe of the different ſides of the commiſſures of the brain; and things being thus ſimilar on each ſide of the brain, can there be a ſtronger argument that they have a common uſe? and that they are not ſubſervient to different faculties of ſoul or body? In which caſe we certainly ſhould have found parts in the brain as different in their aſpect and ſtructure, as the kidneys, liver, *pancreas*, ſtomach, *&c.* which fill up the abdomen.

And how unaccountable is it, that we ſhould imagine that the nerves do any particular office in the glandulous part of the brain, whence they ariſe, when we ſee them ſo equally diſtributed to the parts without? and are equally formed out of the medullary body, made from the collection of the medullary parts, ariſing from the cortical throughout its whole extent?

WHEN

When every part of the brain, to the beſt of our obſervation, concurs to form thoſe cords we call pairs of nerves, and the reſt of the medullary part which joins the ſpinal marrow; to imagine that the brain has any other uſe, than to ſupply them, is to run out of ſight of land, without helm or compaſs, and give ourſelves up to wandering and roving. I allow, that with the brain the mind is generally in great diſorder: but this, I have reaſon to ſuſpect, ariſes from its affecting the mind no otherways, than the other parts of the body are found ſometimes to do; though I allow, from its make, and the ſenſibility of its membranes, and the manner the blood-veſſels are involved with them, while all of them are ſo compactly packed up within the rigid ſcull, that more violent diſturbances to the œconomy, and thence to the mind, do more frequently and eaſily ariſe from this, than from any other part. In theſe circumſtances, a ſlight compreſſion near any of the more conſiderable blood-veſſels, while entering or paſſing from the brain, muſt cauſe a very great diſturbance: for, ſhould the blood be prevented from en-

tering, the continual impulſe it receives from the heart, muſt expoſe the neighbouring veſſels to great violence, while the brain itſelf is defrauded: and, by intercepting the return of the blood, the brain at once muſt be quite compreſſed, and all it's fluids quite damm'd up and ſtopp'd in their courſe: and ſuch a ſtoppage in the courſe of the humours, makes the mind always diſappear; and as this takes place prior to, and more eaſily than a general compreſſion of the nerves, we have more reaſon to ſuſpect it for the more ordinary cauſe of ſuch diſorders.

We have already, in our treatiſe on muſcular fibres, obſerved, that epilepſies and convulſions are the native product of the irritation of theſe fibres, while nothing of the kind happens from preſſing, ſtimulating, or even tearing and cutting the cortical and medullary parts of the brain; and which, when done to the nerves, is never known to produce any thing but a palſy of the parts they ſupplied. And we find, that any thing which ſtops the circulation, where-ever applied, produces a kind of apoplexy, attributed for ordinary to a compreſſion of the brain; and indeed,

indeed, when its ſeat is elſewhere, it is not attended ſo much with the noiſe in the ears, the confuſion in the ſight, *&c.* which are reckoned concomitants of the diſeaſe, and ariſe from the ſituation of theſe organs; which ſituation likewiſe makes their effects laſt longer, and prove more dangerous: the ſcull yields nothing, and therefore the ſmalleſt ſwelling of the parts within, makes an univerſal compreſſion of longer duration, than when perſons are ſtruck down by violent attacks on ſome other part, the *ſtimulus* of a looſe tooth, *&c.* It is certainly very raſh to land every diſorder upon the brain, where the mind is affected, without any proof. When we turn chearful with a glaſs, we muſt reckon the brain firſt invigorated, though the fatigued find its effects before it has well reached the ſtomach: nay, we often find a briſker air, an agreeable ſmell or proſpect, do the ſame; for a well-pleaſed mind has generally a body pliant to its will and humour, and does not regard the ſmaller achings.

The reverend Dr. *Hales* brought a dog to life and vigour, by preſſing effete air into his lungs, ſo as to diſtend them; and I have found

found the ſoul diſappear, in a perſon when diſcharging his hydropic water, as oft as the tags of the belt, with which he was ſwath'd, were left looſe; as I obſerved when ſpeaking of the circulation: and in every inſtance where the circulation fails, ſo does the man; on which account the inſpired writers ſeem to have placed the life of the animal in the blood. Our mind never appears in a dead machine, as it is for the time, when the blood ſtops; and more or leſs, the more or leſs it is ſtopp'd in its courſe. The weak perſon, with looſe fibres, has no ſoul at all when the mercury falls, or the hygrometer indicates moiſture in the air; ſo that the well tempered air would ſeem to be his life; tho' a cloſer view ſhews, that it chiefly ariſes from the effects it has firſt on the lungs, and by them on the circulation; to which we muſt attribute any change in the nervous juice, if then any happens to it; as, we reckon, we have illuſtrated in the former treatiſes on muſcular motion, the circulation and reſpiration. The forming a right notion of theſe, muſt diſcover to us the ſhare they have in the œconomy, and what changes in the mind happen upon

upon their changes; and help us to reſtrict the brain in its dominion, which ſeems to have uſurped the authority of moſt of the other parts, without a juſt title.

If what, I reckon, I have put in a pretty clear light, ſhall be admitted as juſt, that the acceſs the mind has to act upon the muſcles, depends much upon the diſpoſition of the muſcles themſelves; I mean, upon their being ſtretched; it muſt be very ſuperfluous to ſeek any further preparation from the nervous juice; this muſt make us look, as we ſaid, upon the muſcles ſcattered over the whole extent of the body, as the different ſtrings of a muſical inſtrument directly to be played upon by a *ſtimulus*, or the mind: and to make the mind do it by the mediation of the nervous juice, in which we find no fitneſs for the mind to act upon it, nor know the laws by which it ſhould move, to any purpoſe, when touched, is to involve ourſelves in obſcurity, after diſtinct proſpects had been opened to us.

Carteſius's whim, that all the nerves centered in one point, where he confined the ſoul, is now ſufficiently expoſed by anatomy, which could

could never countenance the ſuppoſition. But what have we put in its place? nothing at all we can venture to deſcribe. Two or three, of late, have indeed pitched upon the *corpus calloſum*: why, they tell us, this never was deſtroyed, without incapacitating the mind to act in the body; and here there is a great confluence of the nerves from the different ſides of the brain. But how fond have they been to graſp at the *hypotheſis*, when they would not conſider, that great numbers of theſe employed about the voluntary muſcles, have no connexion with this *corpus calloſum*, at leaſt immediately; theſe, for example, of the extremities and ſpine coming from the ſpinal marrow; all which parts loſe their power of acting, upon the diſeaſes of the ſpine, as much as others on the diſeaſes of the head.

But, further, their aſſertion, that the deſtruction of this part is attended with an abſolute loſs of the mind's authority over the voluntary muſcles, is not agreeable to fact. *Wepfer*, *hiſtor. apoplex.* 14. *ſchol.* 2. obſerves, that this, with many of the adjacent parts, were ulcerated and torn in appearance, and yet the ſenſes were entire, immediately before the

the perſon's death, though formerly he had raved. And *Tulpius* and *Marchettis* ſupply other examples; and *Ridley, obſerv. pract.* 34. *Galen* is poſitive he ſaw a young man cured in *Ionia*, wounded in one of the ventricles, *de uſu part. cap.* 8.; and, after making experiments, he argues, that the anterior ventricles ſuffer leſs by wounds than the reſt. *De placitis Hip. lib.* 7.

Now, as *Lanciſius* and *Peyronie* have given a great number of inſtances, where every other part of the brain has been deſtroyed, without deſtroying the ſenſes or the action of the muſcles, we muſt acknowledge, that there is no one place of the brain neceſſary for the ſenſes and muſcular motion.

The learned Profeſſor *Diemerbroeck*, in the 5th chapter of his third book of Anatomy, argues much to my purpoſe; for, after citing the different opinions of the ſeat of the ſoul, he concludes, *Verùm omnes dictas opiniones admodum dubias eſſe conſtituit experientia, ita ut nihil ferè certi poſſit diſcerni, tam de loco in quo facultates illæ peraguntur, quàm de modo quo peraguntur; multa enim exſtant exempla à Nicolao Maſſa, Carpo, Fallopio, Viga, Ariæo, Angenio,*

genio, Andrea à Cruce, Petro de Marchettis, aliisque præstantissimis practicis notata; quibus è magnis vulneribus capitis notabiles cerebri portiones prodiere et rescissæ sunt, integris manentibus modo dictis principibus functionibus. To these he himself adds some considerable examples, and at last cites *Kerkringius* for an instance, where, in a boy of five months old, no brain was found, but a slimy water in place of it; and therefore calls the story in question: for though he allows, that every part by itself might be dispensed with, without the loss of any of the faculties of the soul, yet he would not grant, that these could subsist entire, when the whole brain was wanting or destroyed: in which opinion *Bidloo* so far joins him, as to call *Kerkringius*'s histories, and *Le Clerc*'s to that purpose, unaccountable fables, as *Morgagnius* observes (*adver.* 2. *animad.* 35.) who at the same time confirms what *Kerkringius* and *Le Clerc* have advanced, by his own and his friend's observations.

By an impartial inquiry, it would then appear, that no bowel is more frequently mutilated,

tilated, and even quite deſtroyed with leſs injury to the œconomy than the brain.

The Hon. Mr. *Boyle* tells us, in the 1ſt exercitation of the 2d part of his treatiſe on the uſefulneſs of Natural Philoſophy, that after cutting off the head of both the male and female fly, parents of the ſilk worm, they engaged in copulation; and that the largeſt tortoiſes live many days without their heads. And we find, *Philoſoph. Tranſact.* N° 226. *p.* 439. that a pigeon, having its ſcull emptied of its brain, and filled with flax, ſearched for food, and did all the actions of life: and dogs lived ſometime, now wanting the *cerebrum*, now the *cerebellum*; but not without both, except by blowing up the lungs: and who can but ſuppoſe, that, in larger animals whoſe blood-veſſels are much larger than in the leſſer, ſuch operations ſhould carry greater danger along with them, and require greater caution in managing, from the loſs of blood only? So that the difference of the effects in them does not at all argue that the brain is more neceſſary to the one than the other; and the leſs, that we have ſo many examples in the larger animals, of their keeping up their

vigour and life after the loſs of the brain; as we obſerved above. To which we may add theſe inſtances *Ridley* gives in the laſt chapter of his treatiſe of the brain, and what *Bartholine* cites in the 91. *obſ.* of his 6th *cent.* and *Bonetus ſepulch. ſect.* 1. *obſ.* 86; amongſt which we have the hiſtory of an ox's brain quite petrified, ſeen at *Sweden* by good judges; as there was one at *Padua*, by *Bonetus*'s account, *Medic. ſept. ſect.* 4. *cap.* 4. and one at *Paris*, as is narrated in the Memoirs of the academy 1703, which was ſo vigorous before it was knock'd down, that he eſcaped ſeveral times the ſlaughterer's hands. I ſhall add one of a cow, well atteſted in this country, no leſs remarkable than any of them, in a ſupplement to this treatiſe. Mr. *Kay*'s caſe, narrated in the *Philoſoph. Tranſact.* N° 277. *p.* 169. is one of the moſt remarkable I have met with in the human kind: a cancerous ulcer began in his cheek, eat out his eye, and through the *os frontis*, *dura mater*, and continued ſo long, that gradually the whole brain was ſpent; ſo that when he died, nothing was found in the ſcull, but about a ſpoonful of black putrid matter, and yet he

loſt

loſt no ſenſe, or the motion of any part, nor had he any convulſion or ſpaſm: it was certainly a great chance, but that the deſtruction of ſome large veſſel ſhould have carried him off long before the whole brain had diſſolved; but, where nature does the work, it often happens, that ſuch hazards are evited. And thus ſo many children born without the brain, who are otherways entire in all their parts, eſpecially the nerves, as *Morgagnius* particularly obſerves in the inſtances we referred to: and thus likewiſe oſſifications and petrifactions of that bowel, without any apparent loſs or diſorder to the other parts; whereas the Anatomiſt would have had difficulty to have done the work, though he goes a greater length often, than the current accounts of the way the brain is employed can admit of.

Is not the brain of uſe, then, ſince it can thus be diſpenſed with? No doubt it is; but we find many parts occaſionally diſpenſed with, which nevertheleſs are of undoubted uſe, as the ſpleen and kidneys, *&c.*

WHAT ſhall we then allow for its province, ſince both ſenſe and motion ſubſiſt without it? Nothing but what I have already hinted at, the

the keeping ſtores for the equal and ready ſupplies of nouriſhment promiſcuouſly to every part.

To ſhew why I entertain ſo ſingular an opinion, I muſt ſhew how far it is fact; and then how the parts are ſupported under the mutilations and total abſence of this bowel, as muſt happen in the caſes we cited above: for ſince we allow theſe caſes of ſufficient force to overthrow the current theories, of ſenſe and motion being derived from the brain, it is hard to conceive why they are not reckoned ſo likewiſe, to ſhew that the immediate nouriſhment of the parts cannot depend upon it.

To underſtand the true ſtate of the nerves, I muſt refer to the account we gave of them, when ſpeaking of the diſtribution of the fibres, in the 2d chapter of the firſt Eſſay; where we ſhewed, from that diligent inveſtigator *Wepfer*, that the nerves have every where an acceſſion of veſſels as they paſs through the body; ſo that they rather increaſe in bulk, the farther they have run from the brain, than diminiſh: and from theſe communications and acceſſions they have,

we

we muſt be ſenſible, that they muſt be ſupplied from every part of the body as they paſs; and the more, the more their ſupplies from the brain are intercepted. This allowance we are obliged to make from *Morgagnius* and *Valleſnerus*'s obſervations, and that of ſeveral other accurate Anatomiſts, that, in theſe caſes where the children were born without brains, their nerves, through the whole extent of the body, were nevertheleſs as large and well grown, as in the ordinary caſes where the brain was entire; which can never be accounted for, except by allowing, that when the brain is defective, other parts can ſupply the nerves.

And thus we find a very great caution uſed to prevent the nerves being ſtarved under the greateſt loſſes; though we muſt be ſenſible that the more ſudden deſtruction of the brain is not ſo eaſily ſupplied; for it may eaſily be ſuppoſed, when the parts communicating with the nerves ſupply other parts, that they will contribute little for them, when kept full from the principal ſource, the brain; and conſequently if this ſhould be deſtroyed, it would take ſome time before the by-ſtreams

would

would change their courſe, and give a ſuffici-ent allowance for the nerves. We find this in the arteries themſelves: if at any place we tie a principal branch, as is done in the operation for the *aneuriſm*, it is ſome days before the pulſe be found below; that is, before the ſmaller branches allow ſuch a free courſe by them, as was by the larger. No wonder then that it takes a much longer time before the nerves get a ſufficient recruit, from the very obſcure veſſels which ſupply them, after their exit from the brain; and that the brain when ſuddenly deſtroyed, ſhould leave the nerves in ſuch a ſtarved ſtate, as to make them uſeleſs, and that death ſhould follow upon the operation: whereas, when the brain turns corrupt, or hardens gradually, there is a demand made upon the leſſer ſtorehouſes, which get time to gather and increaſe as the demand riſes; as happens to the tree which ſtands between two other trees, and has its branches on each ſide made to inoſculate with theirs; when the inoſculation is completed, you may ſafely raiſe the roots of the middle tree from the ground, and let them hang looſe in the air, for it will have ſufficient recruits from the neighbour-

neighbouring trees; which it could not have till it had been joined to them for ſome time, and thereby made the courſe eaſy through the new channels.

And the method of cure in palſies, by ſtrong friction, urtication, and other forms of *ſtimulus* applied to the parts affected, ſhews how much the new courſe may be improven by topical medicines, when the advantages of the firſt are loſt. *Vid. hiſtoire de l'academie Royale à Paris, obſ. anat.* 5. *ann.* 1741.

But nothing ſeems better fitted to let us know the changes the nerves are capable of, than the obſervations by P. P. *Molinellius* in the *Bononian* commentaries, *vol.* 2. *p.* 2. who gives us great reaſon to ſuſpect, that either too many nerves have been tied at once, when the animal died by that means; or, in other caſes where only one part was affected, by tying the nerve ſerving it, that they had not given the animal time to recover its loſs; which he found it did in length of time: for though, upon tying the cardiac nerves upon one ſide, the dog was not a little diſturbed in its motions at firſt; yet four on whom he made the trial, recovered againſt the 20th day

after

after the operation. And as to the loſs of the motion of the part, upon tying the principal nerve, he denies it abſolutely, having ſeen the contrary in ſeverals on whom the operation for the *aueuriſm* had been performed; and therefore gives this remark upon it, *Quo tempore in homine nervum conſtringis, eo doloris vim planè majorem is percipit, quàm ſi arteriam tantùm devincias; dolorem verò major aliqua ſenſûs ac motûs jactura conſequitur: atque hæc tamen brevi evaneſcunt; idemque curationis exitus, ac ſi penitus abſuiſſent: quod ſi aliquandò contingat, ut qui arteriam ſimul cum nervo ligaverint, noxam obſervent aliquam non contemnendam, ii videant porrò ne nervum pungendo læſerint.*

It is certain, that many misfortunes happen, in the courſe of experiments, that ariſe from other ſources, than what we at firſt imagine. What we have advanced, ſeems indiſputably to ſhew, that not only the work of particular nerves may be ſupplied by the neighbouring branches, but even that of the whole brain, by the ſupplies the nerves receive at the other parts of the body: and as this happens in fact, it demonſtrates ſufficiently,

ently, that the principle which determines the motion of the mufcles cannot be feated at the brain. And what other can we imagine to be the defign of every part having nerves from fo many places, but for its fecurity upon the lofs of one or more of its branches, as moft parts are ferved with arteries from different quarters? how many different branches of nerves ferve the eyes, how many the heart!

THE next queftion which arifes from our doctrine of the nerves, is, what determines the flux of the animal fpirits by them, for which there was always fuppofed fome power in the brain? Which leads us to fhew the particular advantage of the doctrine advanced above.

As far as I can yet underftand, there are no inftances of impulfe forcing a fluid, however fubtile, into the leffer or capillary veffels: the attraction of the fides of fuch veffels, upon the fmall quantity which enters them, feems to prevent this; and therefore, though we find every where fuch veffels employed by nature in her works to convey fluids, yet we find no where that impulfe is trufted to im-

pel them, but ſome other method. And thus we find that plants and trees have their roots ſpread thorough the inactive earth, where the juices have nothing to impel them: nevertheleſs, theſe juices are often found riſing in the plant with a very great flow, and even to the tops of the higheſt trees; as we find by Mr. *Hales's* experiments, who demonſtrates that they riſe in proportion to the ſurface of their leaves, and the heat applied to them. Whence it is evident, that it is the emptying of the veſſels at the one extremity, that makes them take up or abſorb the fluids at the other. It is certain, that the veſſels of an animal have this power: inject a thin fluid into any of their cavities, and open them after ſome hours, you ſhall find it gone. And Dr. *Keil's* experiments ſhew, that the whole ſkin has this property; as we obſerved when ſpeaking of the perſpiration. And what veſſels can be better fitted for this than the pulpy, porous nerves? and as the whole bowels and their veſſels ſeem to be made up of them, by what we obſerved from *Wepfer*, and what other Anatomiſts have obſerved, the perſpiration of theſe bowels muſt

empty

empty them moſt certainly, and thus make a demand upon the fluids communicating with them: ſo that the warmth of the blood, which ſupports the perſpiration, muſt keep up a conſtant flow by them; as much as the heat of the ſun upon the leaves of the plant, ſupports their perſpiration, and the riſing of juices by trunk or ſtem, and, laſtly, the abſorption by the roots.

THUS it is we ſuppoſe every part to make a demand upon the brain by means of the nerves; and, of conſequence, every part muſt ſhare in its ſtores, in proportion to its expence. There is no need of any arbiter at the brain to judge of its wants: every part of neceſſity judges and demands for itſelf, and will make a demand on the leſſer ſtorehouſes, when the principal fails, if allowed time to do it; as was ſhewn above.

BY this account of things, then, the brain ſeems to be the great repoſitory of the purer and more active part of the blood, deſigned for a recruit to all the parts of the body promiſcuouſly, where-ever the nerves are diſtributed; that is to ſay, for the bones, cartilages, nails, membranes, glands, *&c.* ſince they ſeem

to

to have an equal ſhare of nerves. And, conſequently, if all motion and ſenſe are managed and formed by particular organs, fitted to that purpoſe, (as we have ſhewn particularly in the muſcles, and are to ſhew immediately as to the ſenſes), and theſe organs are again ſupported by the nerves in common with the other parts of the body, then we muſt ſee, that both ſenſe and motion muſt fail, by a total interception of the nervous juice; and this without allowing that the nerves are the immediate ſprings of either of them, or that by them the ſoul has an immediate communication with the organical parts, diſtributed at greater or leſſer diſtances from the brain.

We muſt likewiſe allow, from this account, that heat is of equal importance to both ſenſe and motion, as what the nerves are, ſince their fluid cannot move or be conveyed to any of the parts of the body without it: and thus extreme cold, and want of nouriſhment, muſt equally render uſeleſs the organs of ſenſe and motion, and both of them cauſe irreſiſtible ſleep.

This new doctrine concerning the ufe of the brain, and its being fo paffive in the animal œconomy, I have ventured to publifh with the greater confidence, that, in my firft Effay, I have fhewn, that, in the performance of mufcular motion, the mufcles themfelves were fitted to qualify one another for exerting their powers, and fubjecting them to the influence of the mind, and thereby left no objection from that quarter: and further, that the connexion of the fibres, and the influence the mind exercifes over them, promifes fair to account for thefe fympathies among the different parts, in their movements and fufferings, which ufe to be attributed to fome imagined alliance among the nerves: for though in many cafes of the moft violent convulfions, the pain caufing it arofe from one point, and obfervably made a regular progrefs from it through the body, till it quite overwhelmed the perfon in the ftorm; yet, in other cafes, the pains feem often, *per faltum*, to attack the parts moft diftant one from another; of which we gave examples, where parts moft difpofed for pain and contraction feemed to be their ordinary feat: but

but ſomething which carried the attention elſewhere, made a ſhort tranſlation of it, as the ſcratch of a lancet, or a bliſter, which *Morgagnius* calls *clavum clavo extrudi*, in his *epiſt.* 13. *art.* 7. concerning *Valſalva*'s writings; where, and in the neighbouring articles, he has much to our purpoſe; ſhewing, that, for all the currency of theſe opinions of the ſympathy of the nerves, yet the moſt diligent Anatomiſts do not agree, if the correſpondence is by the arteries or nerves; as in that famous experiment of burning the ear for the toothach; where he acquaints us, that *Diemerbroeck* attributed all to the ſearing a branch of the carotid, while others found from that operation no benefit at all; and when they did, I would have made it the *clavum clavo*; of which I gave formerly examples, in applying bliſters to the knobs of the ſhoulders. And I ſhall conclude this with one from *Morgagnius*, in the place I cited; *Sanè aliquâ ejuſmodi ratione eveniſſe crediderim, quod, me olim, ſtudiorum causâ, Bononiæ commorante, in quadam virgine tentatum eſt, quæ non ita pridem à cephalæa liberata, in alterius temporis dolorem inciderat, quotidie mane redeuntem,*

untem, acerbum adeo, ut clamare, delirare, ad extremum ſine motu & ſenſu concidere, & quatuor ipſas horas ſic jacere virginem cogeret: huic, aliis omnibus præſidiis irritis, vir ille qui medicinam faciebat, (quæcunque illum ratio moverit), duos ex eodem latere ſuperioris maxillæ dentes, quantumvis ſaniſſimos, evelli juſſit: quibus evulſis, dolor non amplius redivit. How ſuch effects ſhould follow from ſuch operations, I cannot think difficult to imagine, after conſidering the particular tenſion neceſſary to make the ſmalleſt touches ſhew themſelves violently; and how certainly their effects ceaſe, on intercepting or otherwiſe diverting any flux upon the part, upon which the periodical tenſion depends: and thus I have ſeen a ſingle ſnuff cure the *catalepſis*; and the mind likewiſe loſes her intention on the change of ſcenes, as we juſt now obſerved.

It now remains, that I ſurvey the different ſenſories, ſo far as is neceſſary for our preſent argument: concerning which ſtill greater liberty has been taken, in making the nervous juice move backward, on the ſmalleſt touch we feel, at the greateſt diſtance from the brain

to

to the ſuppoſed common ſenſory there: a ſuppoſition that nothing could make us allow, but the greateſt prejudice! What ſhould make the juices run back from every point of the body, to which we are poſitive they have a conſtant flow?

APPENDIX.

Of the Senses.

CHAP. I.

Of the senses whose organs are more obscure.

THE manner in which most Physiologists have spoke of the organs of touch, placed, as it would seem, over the whole skin, would persuade us, that they believed they were pure nerves, no otherways formed than what they were at their first rise from the brain; as *Boerhaave* seems to reckon these serving the organ of smell, equally distributed through the whole *membrana sneideriana*, lining all the *sinuses* communicating with the nose, (*Inst. art.* 495.); and as most indeed seem to reckon these of taste, the stomach, *penis*, *&c.* But what *Ruysch* observes, *art.* 5. of his first *adversarium*, that the nerves did not end less variously than the arteries, should have given a suspicion that they suffered considerable changes in their course; especially joined with

Wepfer's obſervation, that in fact they increaſed in their progreſs: this ſhews, that the nerves are join'd with other filaments, with which they form the compoſition we call the extremity of the nerves. And thus it is, that tho' moſt of the leſſer organs of ſenſe have only the appearance of *papillæ*, to form the ſenſation, as over the whole ſkin, ſome part of the *membrana ſneideriana*, (*Sanctorin. obſ. anat. art.* 11. *p.* 91. 92.), the tongue, *penis*, *&c.*; yet theſe are all different: for it is agreed by obſervators, that theſe of the tongue are *capitatæ*, (*Heiſt. anat. vol.* 2. *p.* 20.), thoſe of the ſtomach much leſs; ſo that we find them denied by ſome, (*Ibid. not.* 9.): and theſe of the fingers, though larger than at the other parts of the ſkin, yet appear only pointed eminences, (*Vid. Ruyſch, fig.* 17. annexed to his epiſtles, *Epiſt. prob.* 1. *fig.* 14. *theſ.* 10. *fig.* 3. *t.* 3.): they are flat again at the breaſts, as they are at the *penis*, (*Idem. theſ.* 10. N°. 34.) I had occaſion to ſee thoſe at the tongue to the greateſt advantage in pulling a tooth; upon ſcarifying the gum, the tongue was beſmeared with blood, and then, on pulling, the man contracted his tongue ſo much, under the

pain,

pain, that the *papillæ* appeared eminent over its whole ſurface, of a white colour amidſt the blood, and of the bigneſs of a ſmall pin's head, ſo thick, that the whole tongue appeared checquered: here each *papilla* appeared as big as any of the branches of nerves at its entry to the tongue; ſo that together they muſt have exceeded greatly all the ſimple nerves entering the tongue, not only for ſenſations, but the uſe of the muſcles and other parts; and conſequently the *papillæ* muſt be ſomething elſe than mere nerves; as muſt be the nails and many other parts, we, in a looſe way of ſpeaking, call nervous; while they differ greatly from one another in appearance, conſiſtency, *&c.* I could eaſily go in with *Wepfer*'s opinion, and others of the moderns, who ſuppoſe all the parts originally from the nerves, if we ſtill allow them to be nerves, while increaſing in bulk by the acceſſion of other parts: but this allows ſome kind of vegetative nature in them, and carries us quite from the common notion concerning the nerves: for example, what idea ſhould I give of the upper half of a gooſe's bill, if I ſhould ſay no more of it, but that it was a nervous

part,

part, becauſe *Wepfer* traced a branch of nerves from below the eye, which increaſing in bulk in its progreſs, was quite ſpent upon this part, and ſeemed to make up the whole of its ſubſtance? and what anſwer ſhould I have, if I ſhould demand, why ſuch a ſhare of nerves to this part, which has ſo little uſe for any extraordinary ſenſation, and has no motion amongſt its parts? which is likewiſe the caſe with the glandulous parts, and the bones, whoſe involving membrane has indeed a very quick ſenſe, as likewiſe the internal; but the nerves running through their ſubſtance, nothing remarkable this way; and therefore not the nerves, but ſtretched membranes have the ſenſe. It is more than probable, then, that the *papillæ*, which form certain ſenſations, are ſomething elſe than pure nerves, and that they differ greatly amongſt themſelves; and thus the ſame thing, ſuch as *ipecacuana*, or a roſe, *&c.* applied to them raiſe a moſt different feeling; which we would not expect, if the *papillæ*, at noſe, tongue, ſtomach and ſkin were pure nerves. The different feeling, then, from the ſame object, applied after the ſame manner, argues a different organ, and other parts

parts than pure ſimple nerves; as is moſt evident in theſe more enlarged ſenſories of hearing and ſeeing, which nature has ſo enlarged, that we can view their various parts, and judge from them more diſtinctly, what ſhare the nerves have in the ſenſation; and therefore we ſhall be more particular in our account of them.

CHAP. II.

Of the Hearing.

NOTHING can be more remarkable than the *apparatus* at the ear, firſt, for introducing the air to advantage, by its external parts; and then to communicate its ſhock to the internal, by the parts which lie between the two.

THE entry is very patent, and has ſeveral ridges raiſed round it, directing the more parallel waves of the flowing air into it, which combined by the narrower body of the paſſage, are thus landed advantageouſly upon the membrane, laid obliquely croſs its internal

nal extremity: between this membrane again, and that which opens into the internal ear, there is a ſmall chain of bones, lying in the moſt moveable poſture imaginable, croſs the empty ſpace, called the *tympanum*, lying between the external and internal ear. This *tympanum*, from the extremity of the external tube, covered with the membrane we have mentioned, to the ſmall oval membrane, that lies immediately above it, and covers the entrance into the internal ear, is not more than a ſixth of an inch, which we may call the wideneſs of the *tympanum*; and in circumference, about a third.

The chain of bones does not lie directly croſs this paſſage: but the firſt lies parallel to the larger membrane, at the extremity of the external tube, which is called the *membrana tympani*; and that in ſuch a way, as to have its ſmaller end, like the extremity of a ſhort pin, involved in the duplicature of the membrane, from the circumference to the center; while its head, formed like that of a club, placed without the circumference of the bony circle, to which the membrane is attach'd, is articulated to the body of the next bone lying

lying on it, as an hammer on the anvil; and therefore Anatomiſts give them theſe names. The anvil lies likewiſe parallel to the membrane with its two legs; one of which runs ſo far over it, and parallel to the handle of the hammer. To the extremity of this, a bone, in form of a ſtirrup, is articulated, by means of a ſmall oval bone, diſtinct from both, and not exceeding, in bigneſs, a ſmall millet ſeed: the broad end of the ſtirrup enters an oval paſſage, which leads to the *veſtibulum*, involved in the duplicature of the membrane, which covers that paſſage; and thus ſtands perpendicular, from the leg of the anvil, to the upper ſide of the *tympanum*: theſe four bones then lie in ſome kind of zigzac courſe croſs the *tympanum*; articulated and faſtened with ligaments one to the other; ſo that nothing can be more vacillant. And thus we find how the ſmalleſt motions of the air muſt be felt upon the membrane covering the paſſage into the *veſtibulum*; which now we muſt deſcribe, with the parts it leads into.

The *foramen ovale*, in which the ſtirrup is placed, opens into a ſmall cavity, almoſt round, which ſcarce would admit a corian-

der

der ſeed, called the *veſtibulum*; having three canals exterior to it, and the *cochlea* lying on the interior ſide: the length theſe three parts take up, is not two thirds of an inch; and the canals open into the *veſtibulum* by five paſſages, two of the canals uniting into one: and one half of the *cochlea* opens likewiſe into it; but the other is joined to the membrane covering the *foramen rotundum*, which is another paſſage into the *veſtibulum*, from the *tympanum*, lying ſomething more inward and backward, but not ſo high as the oval. The *veſtibulum*, canals and *cochlea*, taking up a large half of the *os petroſum*, at its riſe, by one name are called the *labyrinth*; all of which is covered with a membrane we reckon the internal *perioſteum*; and the two paſſages, from the *tympanum* to the *veſtibulum*, are covered both with it, and the external *perioſteum*, which lines the *tympanum*; but the internal is ſo little fix'd to the ſides of the canals, that *Valſalva* took them for cords running through them: but *Winſlow* allows theſe to be no other than the *perioſteum*, which eaſily recede from the bones when a little dried. This membrane is always greatly moiſt-

ened

ened, and in infants looks mucilaginous. The *cochlea* is divided into two diſtinct canals, by a duplicature from it, one of which, as we obſerved, opens into the cavity of the *veſtibulum.* The vibration of the firſt membrane, then, to which the air has acceſs, muſt, by means of the ſmall bones, land upon the lining of the *foramen ovale,* and by that means communicate to theſe different linings of the three different cavities to which it is connected; and in themſelves always on the ſtretch, and of different lengths and flexures: ſo that, as *Valſalva* obſerves, according to the touch, ſome of them at one time, ſome of them at another, will be made to play, and, on different occaſions, combine differently, to form different ſounds; and thus among them raiſe an infinite variety: ſo that we can be at no doubt, that this internal ear is a corded inſtrument, played upon by the air, as *Memnon's* harp was by the ſun-beams.

Here then, without all doubt, the inſtrument is played; but the queſtion is, whether it is heard here, or in a diſtant apartment: the moſt of Anatomiſts alledge in a diſtant apartment, at ſome common ſenſory, to which

every particular ſenſe ſends its obſervations; the *papillæ* at the toes, though touched only with the ſtroke of a downy feather, not excepted; however difficult it is to imagine, that the gentle ſtroke of a down ſhould raiſe vibrations through one veſſel, to ſuch a length, either in the ſolid parts, or in the liquid it contains; and that whether ſtroked backward or forward.

BUT a ſmall examination into the circumſtances of the ear, raiſes greater objections. The auditory nerve, though of great bulk at its entrance into the *os petroſum*, where the organ for hearing is ſeated, yet ſo obſcure a part of it reaches that organ, that *Du Verney* doubted if any of it entered the labyrinth at all; and the four or five different paſſages, by which a few filaments enter, are rather pores than holes, and ſome of them land at the canals, and others at the *cochlea*; ſo that, thus divided, they do not at all look as if contrived to carry the formed ſound back to one point of the brain, but rather to ſupport with nouriſhment the membranes perpetually agitated with the motions of the air in this hidden labyrinth; for which we cannot reckon them

them too liberally beſtowed: for their faithful attendants, the arteries and veins, paſs with them by the ſame pores; and conſequently, by themſelves, they muſt be exceeding ſmall filaments. Theſe nerves ſeem no way fitted then for conveying the formed ſound, but would rather make it ſplit and diverge when formed: and certainly it muſt be greatly diſturbed, when its canals are wrapt up in common with a much greater multitude of others in the auditory packet, ſcattered to bones and muſcles through a great ſpace; while no more enters the labyrinth, than is proportionally ſhared to other membranes: and theſe who reckon a great ſympathy amongſt the branches of nerves of the ſame pair, how much, in this caſe, ſhould they expect to find the hearing diſturbed under the exerciſe of the muſcles, ſupplied by the *portio dura* of the auditory nerve, than which none are more exerciſed? Which obſervations, with theſe, where it was noticed, that the hearing continued after the whole brain was aboliſhed, muſt ſatisfy us how far the ſoul is preſent with the organ, and is immediately touched by it.

CHAP.

CHAP. III.

Of the Organ of Sight.

WHAT we have obſerved juſt now concerning the obſcure filaments of nerves entering the labyrinth, may be likewiſe obſerved at the eye: for though the optic nerve is of great bulk where it enters the bone; yet immediately, upon its reaching the globe of the eye, it ſeems to terminate in a kind of ſmall knob, without ſpreading into the *retina*, as has been imagined. To ſee this, and the whole courſe of the optic nerve, with its integuments, Mr. *Winſlow* adviſes to make a diviſion through the middle of that part of it, within the bony ſocket of the ſcull, parallel to its ſides, and to carry the diviſion in the ſame courſe ſome length into the body of the eye itſelf; by which, he aſſures us, we ſhall find, that the portion of the *dura mater* which covered the nerve differs from the *ſclerotis*, both in thickneſs and texture; and that the *pia mater* lying under it, enters the body of the

the nerve, and divides it into cellular portions; and that what of it is continued to the eye, does not anſwer to the *choroides*; and that, as the optic nerve ſeems to terminate without entering into the eye, ſo the *retina* is too bulky to be admitted as the medullary part of that nerve dilated and ſpread. By which obſervations we muſt ſuſpect greatly, that the received opinion concerning the *retina* and other coats of the eye, is not ſo agreeable to anatomy as was believed; and that the *retina* ſeems in no ſenſe to be nervous, either as the product of a diſtinguiſhed nerve, or as wrought into a tenſe firm membrane, which form of texture has made ſeveral parts acquire that name; for in fact it is as ſlippery and looſe a membrane as is in the whole body, looking, as *Winſlow* obſerves, like paſte ſpread on a delicate fibrous net-work; and thus ſeems as unfit to be irritated by the touch, or any other way moved, as its origin from the optic nerve is doubtful. But as it is plainly tranſparent to the view, eſpecially when viewed in water in a live animal; as Mr. *Le Cat* informs us had been done by Mr. *Mery* to a cat, and thereby ſhewed, that it conſiſted greatly of

lymphatics,

lymphatics, as has been obſerved by the Anatomiſts *(Vid. Boer. Inſt. art.* 525.), we would therefore ſuſpect, that the *focus* did not exert its force here, but paſſed to the next coat, the *choroides*, which is quite tenſe, poliſhed and opaque, beſmeared on the back with a black pigment, as mirrors with quick ſilver, that the rays may not paſs. Than which nothing can give us a greater ſuſpicion that this very coat is the ſeat of the ſenſe, while the *retina* guards it from the friction of the vitreous humour, as the mucous coat of the inteſtines does the nervous from what paſſes their cavity; and therefore we cannot eaſily allow that the optic nerve receives the ſhock. But ſuppoſe we could, in ſpite of this, perſuade ourſelves that it does; yet ſince Anatomiſts have found, that the optic nerve is a collection of very different parts of the brain, *(Vid. Morgagn. epiſt.* 16. *art.* 12. *ad ſcripta Valſalvæ*), we cannot eaſily conceive where the mind receives the impreſſion, ſince the different filaments would reſolve the formed figure, as much as the eye had united it: ſo that the *focus* ſeems the only proper place for the mind's attention. And thus what we have obſerved of the eyes,

conſpires

conſpires with that of the other ſenſes, and what we ſaid of muſcular motion, to confirm to us, that the nerves have no proper buſineſs either at the muſcles or ſenſes: and the *pia mater* being wrought in with them in their whole courſe, we ſee how they can be ſupplied at a diſtance from the brain.

But, before I quit with the eyes, I muſt explain a little that which I only mentioned, the connexion of the fibres of their different parts, that I may here give a notable example of the connexion of the parts of the body, which I found ſo neceſſary to give us a right notion how the parts communicate their motion and feeling one to another.

Mr. *Le Cat*, with moſt Anatomiſts, reckons the *ſclerotis* a production of a ply of the *dura mater*; but *Valſalva* would have it the production of the tendons of the muſcles of the eyes: Mr. *Morgagni*, examining more narrowly, found, that as the *dura mater* was continued with it on one hand, ſo likeways were the tendons of the ſtraight muſcles quite to the anterior parts of that coat, while from the other hand the tendons, with the tendi-

nous

nous ſheath of the oblique, ſpread to the poſterior parts of it, (*epiſt.* 16. *art.* 37.); and he found, that the *adnata* ſpread its fibres over the *cornea*, as well as the *ſclerotis* did; ſo that in moſt places, every part is involved with another.

AND thus I have at ſome length given an account of the brain, and the nerves ariſing from it, to diſcover their importance, and how they are employed in the body, which, I perſuade myſelf, ſhould help us to judge more mechanically of the actions of the body, *i.e.* more intelligibly than what we have hitherto done; and put us on a method to improve our theory more to the advantage of medicine, to which all our ſpeculations ſhould be deſigned.

BUT I muſt further make an obſervation on the experiments which ſeem to prove the flow of ſpirits by preſſure through the nerves. It is alledged, that immediately upon ſnipping off the head of a frog with a pair of ſciſſars, upon preſſing the ſpinal marrow gently down with a probe, the frog draws up its legs, and upon preſſing the *medulla oblongata* at the *foramen*

foramen magnum occipitis, it opens its jaws, and rolls its eyes. But what is the connexion of the *medulla oblongata* at this part and the optic nerves? Is it to be imagined, that any part of these arises here, where the medullary part of the brain is running into that of the spine? Or is it not much more natural to allow, that the irritation of the probe provoked the dying animal to exert the parts most under its power to move? as we gape and grasp with our hands when prick'd in the soles of our feet.

THE experiments many have made, of setting the diaphragm a moving, by striping down the phrenic nerves, are no less uncertain proofs; for others have found, that, by striping the nerves upwards, that muscle is as certainly set a moving, as in striping up the vertebral nerves of a frog, its legs will move; for in that case the member has a great irritation from the small fibres of the nerve spread through it; as the fibres by which the tooth was hanging, in the case we mentioned, when agitated, caused such a remarkable disturbance.

And thus, I reckon, I have adduced a sufficient variety of arguments, why the received doctrine concerning the brain should undergo a further examination, and other uses for it be considered, than what have yet been admitted.

An Account of the offified Brain of a Cow, killed at Fettercairn, *a Village near to* Montrofe, *in the County of* Angus, Scotland.

IT being my good fortune to be fome nights at a Gentleman's houfe, in our neighbourhood, *Auguft* 1744, attending a patient, with a worthy old Gentleman of our faculty Dr. *Wedderburn* in *Dundee.* Among other fubjects we had occafion to difcourfe of, we argued fome time about the ufe of the nerves, and the difeafes arifing from their diforders, which our patient's cafe naturally led us to: and as it was a fubject I had treated of at length in my lectures, I was prepared to lay before him my fcheme, as I have explained it in the foregoing effay; which, however new, feemed to be pretty well relifhed by my friend. To confirm it, he acquainted me, that the Phyficians and Surgeons at *Dundee*, had, in their collection of rarities, an offified cow's head, which was killed at *Fettercairn*,

tercairn, when ſhe had no ſeeming defect either in her ſenſes or motion.

I took the firſt opportunity to get a ſight of it; and finding it one of the compleateſt brains I had heard of, though roughly vitiated, I drew up the fulleſt account of it I could get. And when it was my turn to bring in a paper before the Philoſophical ſociety at *Edinburgh*, laid it, with the brain itſelf, before them, as I likewiſe did before ſeverals of my correſpondents; amongſt whom there were ſome who could not at all allow it to be the brain, but rather ſome excreſcence from the ſcull; which certainly was a very forced ſuppoſition: for, upon ſurveying it, it is found quite ſmooth all over its ſurface, except ſome ſeemingly carious ſpots at the place I reckon the baſe; and, among theſe, the ſmall granulated pieces which ſhoot out the moſt being quite ſmooth, and as it were glazed over, ſhew there was no coheſion there: ſo that the only place to be ſuſpected for being joined to the ſcull is the ſmall end; which indeed is quite rough, and looks as if it had been broke off from the parts next to it, from the mammillary proceſſes, running upon the *os cribriforme*, which

are

are very large in cows. Now as this is the only part at which we can fufpect a cohefion to the fcull or the parts contiguous to it; what freedom in fuppofitions is it, to reckon that fuch an *exoftofis* had arifen from fo fmall a root, and had fpread to fuch an extent both in breadth and length? Where was there ever found fuch a fmooth and regular piece of bone not natural, except upon fome regular part being offified?

It was further argued, that, upon comparing it with another brain of a cow, it was found much larger, and not at all of the fhape. But who could expect, in fuch a vitious difpofition of a part, that either the bulk or fhape could be preferved? Is it not a fufficient teftimony of the fact, that the butcher found it in the fcull, and depended upon its being the brain: that Mr. *Gentleman*, to whom the cow belonged, received it as fuch, and delivered it to his brother, an inhabitant in *Dundee*, to be delivered to our faculty there; who always look'd upon it as fuch, and no doubt, would then be as particular in inquiring about its circumftances as poffible; as would that curious and learned

Gentle-

Gentleman, *Duncan Forbes* Efq; late Prefident of the Court of Seffion, who was at the place two days after the flaughter of the cow, and defired the brain to be delivered to the college of Phyficians at *Edinburgh*; but was refufed; becaufe of the prior engagement to deliver it to thofe at *Dundee*. I have compared it with two different brains of cows, whence the upper and lateral parts of the fcull were feparated, and found a much greater refemblance between them, than I could expect between a part in its moft natural ftate, and when fo ftrangely changed in its confiftence; which we cannot fuppofe fhould happen, without great diforder about the part fo changed.

WHAT I take to be the *cerebellum*, is indeed fix times, at leaft, bigger than the natural, and is bounded from the other by a chink, running crofs what I reckon its upper part, and pretty deep, inclining forward, and glazed on both fides, as far as we can fee down, as is the upper furface and fides of the whole bone; and the hinder part, which is tuberous, and the lateral parts of the bafe, more prominent than the middle, which is fome-

fomething hollow, and appears as it were carious; but all the other parts, except thefe we reckon broken from the mammillary proceffes, are not only of a glazed fmoothnefs, but in colour of a tarnifhed yellow, as if the *pia mater* was offified with the brain.

AND, befides the bignefs of that part I reckon the *cerebellum*, it is raifed much above its ordinary height, to a level with the other part; and in its middle there is a particular protuberance, as big as a walnut: fo that this part is out of all form; only its undermoft pofterior part confifts of two gibbous portions, as we find the lobs of the *cerebellum*, though thefe are much lefs.

BUT the bignefs and figure of the *cerebrum* are preferved greatly in the offification; for I found the greateft refemblance in it to one of thefe with which I meafured it, and otherways compared it: both of them bulged along the fides of the upper furface; fo that the middle between the two was fomewhat hollow along which the *falx* runs: and both of them from behind tapered forward much in the form of a wedge, for two inches of the fmaller extremity, where they

were

were much of the ſame breadth. From the chink to this in the oſſified brain the length was $4\frac{4}{10}$ inches, and in the freſh $4\frac{3}{10}$. At the chink where the greateſt breadth was in the oſſified brain, the breadth was $3\frac{7}{10}$; in the other, the poſterior part was in breadth $3\frac{8}{10}$; in both the breadth continued much the ſame, except for two inches where both turned ſo ſmall: and the weight of the whole is one pound ſeven ounces and an half merchant weight: of which I have cauſed draw two views; one of the upper part, with a portion of the ſide; and the other of the baſe, and marked what is moſt conſiderable in them. The piece wanting was ſtruck off by the butcher; who, finding great reſiſtance to ſeveral blows he had given with his ax, to divide the head, at length, increaſing the ſtroke, ſaid, *If the devil was in it he ſhould be into it*; and with that blow ſtruck into the oſſified part; which ſo far ſhews that all was ſolid; for if it had not been ſo, but ſupported with the ſoft brain, the ſcull would have yielded as eaſily as in ordinary caſes. Conſidering then the reſemblance it has to the brain, and its ſmoothneſs all over, except at ſome ſeeming-

ly

ly carious parts, and at the fore-parts where it ſeems to have been broke off, it appears a very ill founded ſcepticiſm, to call in queſtion if it is the original brain oſſified: and I ſhould have expected worſe ſymptoms from ſuch a weight lying upon the brain, than from its oſſification, ſince the ſoft brains could not but have been bruiſed and torn, and its membranes greatly fretted by its neighbourhood.

If ſome people, of whoſe judgment I have the greateſt opinion, had not ſtarted the ſuppoſition, I could not have thought it worth while to have anſwered ſuch objections; and as I look on it as a fact of the greateſt importance, in our Medical inquiries, we cannot inſiſt too long in clearing it up. For this purpoſe, after I had got the head in my poſſeſſion, I immediately wrote to Dr. *Haddow*, who was then Phyſician at *Montroſe*, to make inquiry, at the places where the cow was killed, about all its circumſtances: and he, in company with Sir *Alexander Ramſay*, to whom the houſes belonged, poſſeſſed by Mr. *Gentleman*'s widow, owner of the cow, called for her and her ſiſter, and ſeveral of the neigh-

bours who remembered the cow well, and got her hiſtory from them at length. That after ſhe had been in their poſſeſſion about a year and an half, ſhe took a difficulty of breathing, which made her ſnort in her ſleep, and and ſleep ill, and, on this account, they reckoned, fall away in her fleſh, and therefore they made one *Silver*, a Butcher, now dead, kill her. They likewiſe obſerved that ſhe fell down with the ſtroke, as other beaſts do, when killed with the ax; and that, when in life, ſhe eat and drank, ſaw and heard, as well as any cow; and had a calf in the time ſhe was in their poſſeſſion.

The Reverend Mr. *Anthony Dow*, Miniſter of the place, at whom we likewiſe inquired concerning the cow, gave us much the ſame account; and ſays poſitively, from what he learn't, that there were no brains found in the ſcull, but this oſſified lump only.

But ſome time after I had ſent the oſſified brain to *Edinburgh*, underſtanding that it had given occaſion to *Duncan Forbes* Eſq; Preſident of the Court of Seſſion, to acquaint Mr. *Monro* Profeſſor of Anatomy with its

hiſtory;

hiſtory; as I expected ſomething accurate from the Preſident's obſervations, who was one of the moſt learned and curious Gentlemen of the age, I immediately applied to my learned friend the Profeſſor, to know what he had ſaid concerning it, and had the following anſwer to my letter.

Dear Sir,

" The Preſident told me, that, in travelling " North, his landlord at *Fettercairn*, (if I mi" ſtake not) told him, that he had then cauſed " a cow of his to be killed, becauſe ſhe ſeem" ed dull, and was loſing fleſh; that the man " who was endeavouring to cleave the head, " finding a reſiſtance he did not uſe to meet " with, after cutting the bone through with " an ax, examining what made the reſiſtance, " found the brain of a bony hardneſs; that " the people brought the freſh head to him, " who found it oſſified as they had deſcribed it. " I cannot tell whether the Preſident ſaw the " oſſified brain when it was here; but it was " on that occaſion that I aſked him to repeat " the ſtory, which I formerly heard him tell, " and he promiſed to give it in writing to me,

" but

"but was either too much hurried, or too "ſick for doing it, when he was in the place afterwards". Thus far the Profeſſor.

I wrote to Dr. *Wedderburn* ſome years after our converſation on the ſubject, that I might be as diſtinct in it as poſſible; who returned me anſwer, That the cow being dull, and not healthful, was fed to be ſlaughtered, but did not get fleſh; that the butcher, in attempting to open the ſcull after the ordinary manner, found an uncommon reſiſtance, which made him give repeated croſs blows, ſaying, *If the devil was there, he would be in:* thus the ſcull being very much broke, the oſſified maſs came out eaſily; and no body can view it, but muſt be ſatisfied, that it is the whole brain compleatly oſſified. Thus this cautious Gentleman, who was preſent at the delivery of it, and who acquaints me, that Mr. *Gentleman*, from whom they had it, was a perſon of probity and ſenſe.

And this account agrees with what was got from the widow and others concerned in the cow, and that of the Preſident: tho' none of them

them had opportunity to hear one another on the fubject.

There was never any fufpicion of any thing of brain but what was offified.

The beaft was falling away in its flefh; and was more dull than ordinary, though going about with all its fenfes; and the only vifible difeafe elfe, was a breathleffnefs which difturbed her in her fleep, and was look'd on as the caufe of her lofing her flefh.

Whether or not might the offification be continued down the nofe, as the extremity of the brain next to it feems to have been broke off from the olfactory nerves?

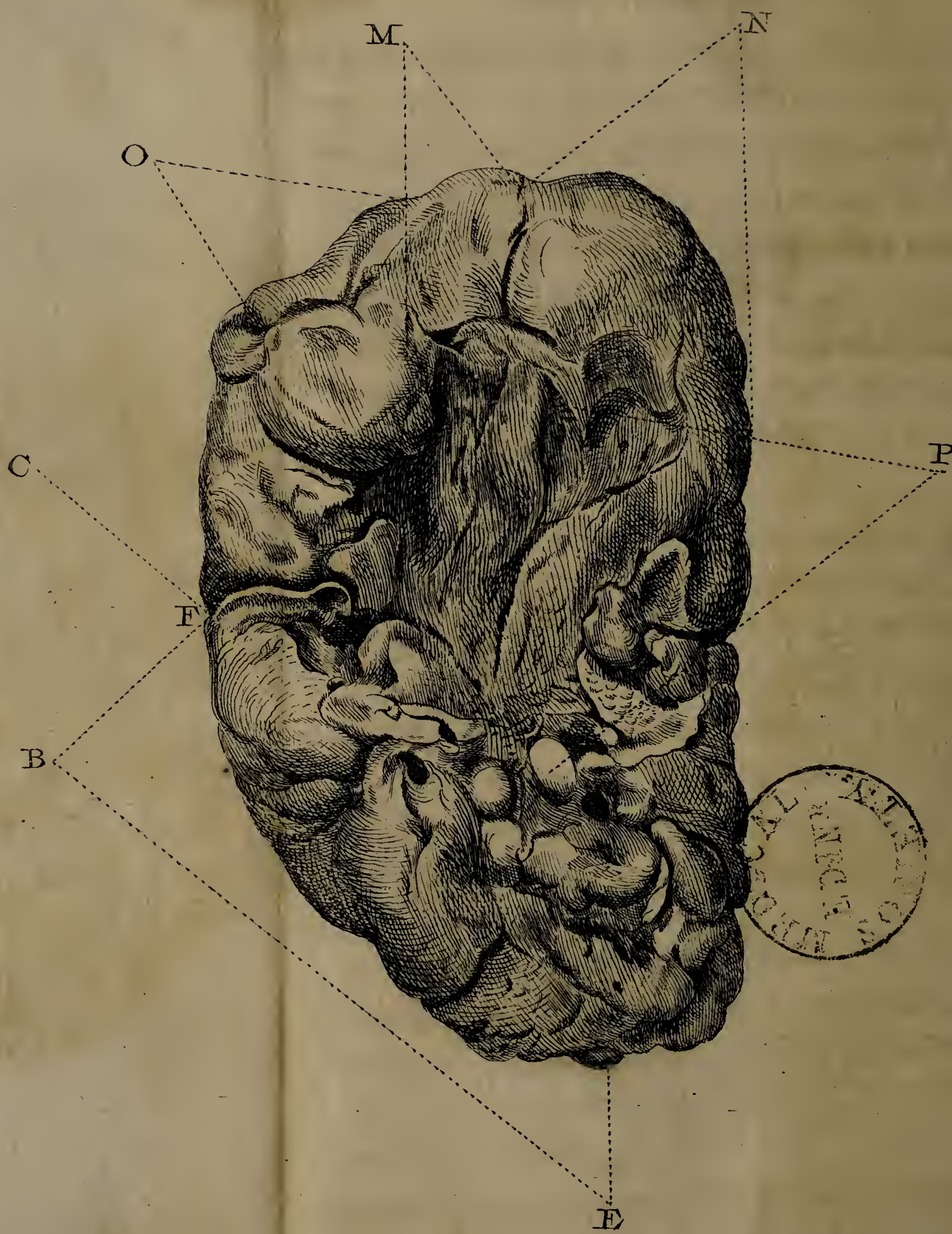
It was certainly a great misfortune that no Anatomift was acquainted with it on the opening the fcull, to confider the ftate of the membranes, the rife of the nerves, *&c.* But as it is, in my opinion, we have a moft certain example how far the mufcles and fenfes can continue in office without the brain, though not without fupplies; fince where the brain was wanting the nerves have been found compleat, which we find accompanied with the *pia mater* at their exit, and to have a like fupply of blood veffels in the whole of their progrefs;

but

but though thus they are ſupplied with fluids, yet, from ſuch hiſtories, we muſt give up the correſpondence of the mind with the different parts of the body, if we confine it to the brain; ſince, in ſuch caſes, their nerves have no communication with its ſeat, that is, with the cortical or medullary ſubſtance of the brain, to ſome diſtinguiſhed part of which they ſuppoſe the mind confined.

FINIS.

Fig. II.



A. Bell Sculp.t

FIG. I.

E A D is the length of the upper ſurface.

The angle C F B is at the chink, where I ſuppoſe the *dura mater* was ſeparating between the *cerebrum* and *cerebellum*: it is ſo wide as to receive a ſhilling, and runs round the ſide to the baſe on the left ſide; but how it was on the other, is not to be known; it being at that place where a conſiderable part of the brain was driven off in opening the ſcull.

K repreſents the gap made by the ax, and is a full inch deep and broad.

L where a ſuperficial ſplinter flew off.

H is the eminence in the middle of the ſurface of the *cerebellum*.

F C D the half of the upper ſurface of the *cerebellum* on the left ſide.

F B E the length of the *cerebrum*.

G a ſmall ſinuoſity along its middle, which, we reckon, opened to the *corpus calloſum*; and on each ſide of it there ſeems to be left ſome veſtiges of the interſtices, between the wreaths of the cortical ſubſtance.

I comprehends ſo much of the lateral parts on the right ſide.

FIG.

FIG. II.

Figure 2. is the bafe, with a view of a fmall part of the left fide.

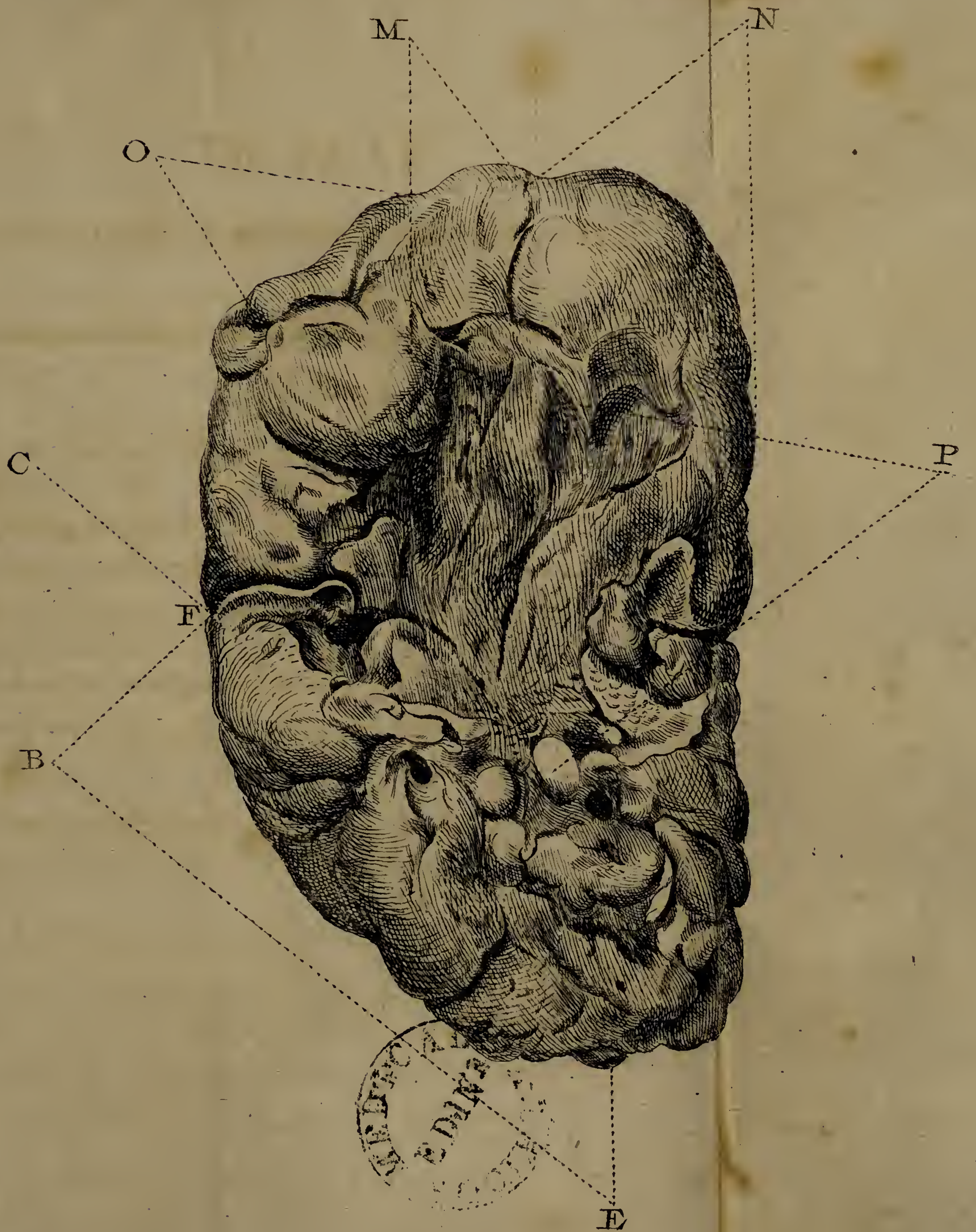
C F B the continuation of the chink round that fide.

F B E the length of the *cerebrum*.

O and N are the gibbous parts on the pofterior part of the *cerebellum*, which leave M between them a fmooth hollow furrow, which runs to P, between whofe legs is comprehended a part of the bafe, which looks fomething carious. This furrow, half an inch broad, is not reprefented by the Painter: it is glazed and yellow as all the parts round it: as are all the fmaller granulated parts, and every other part of the bafe, except what lies between the two lines from P.

When we cut into any part of it, the fubftance is whiter than that of moft bones, and fcarce more porous than ivory.

Fig. II.



A. Bell Sculp.t